

THESIS

ON

OBSERVATIONS ON VISCERAL PAIN,  
WITH SPECIAL REFERENCE TO  
PAIN ORIGINATING IN THE TESTIS

SUBMITTED FOR THE DEGREE OF

M.D.

By

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## CONTENTS

	<u>Page</u>
<u>INTRODUCTION</u> . . . . .	1
<u>REVIEW OF LITERATURE</u> . . . . .	4
Visceral Pain . . . . .	4
Referred Pain . . . . .	6
Visceral Tenderness . . . . .	10
Testicular Pain . . . . .	12
 <u>THE ANATOMY OF THE SENSORY NERVES SUPPLYING TESTIS AND SCROTUM</u> . . . . .	 21
The Scrotum . . . . .	22
The Testis . . . . .	23
 <u>THE DEVELOPMENT OF THE TESTIS</u> . . . . .	 27
 <u>CLINICAL EVIDENCE CONCERNING TESTICULAR PAIN</u> .	 29
I. Pain Resulting from Disease of the Testis	
Torsion of Testis . . . . .	30
Torsion of Hydatid of Morgagni . . . . .	37
Seminoma of Testis . . . . .	44
Epididymo-orchitis . . . . .	45
Trauma to Testis . . . . .	50
Ectopic Testis . . . . .	53
Undescended Testis . . . . .	54
Infarction of Testis . . . . .	55
II. Testicular Pain Sensation in Various Clinical States	
Osteomyelitis of Spine . . . . .	56
Effect of Nephrectomy . . . . .	57
Effect of Lumbar Sympathectomy . . . . .	60
Effect of Extra-dural Anaesthesia . . . . .	62
Effect of Spinal Cord Section at Various Levels . . . . .	63
III. Illustrative Case of Referred Renal Pain.	71
IV. Investigation of Testicular Sensation in Patients Suffering from Hydrocoele . . . . .	72
 DISCUSSION /	

	<u>Page</u>
<u>DISCUSSION</u> . . . . .	86
The Site of Pain Caused by Disease of the Testis . . . . .	86
The Nature of Pain Arising in the Testis . . . . .	89
Testicular Tenderness and Local Pain . . . . .	90
Sensitivity of Tunica Vaginalis Testis . . . . .	91
Sensitivity of Peritoneum . . . . .	93
The Pathway of Pain Impulses Arising in the Testis . . . . .	96
The Mechanism and Rationalisation of Testicular Pain . . . . .	99
 <u>SUMMARY</u> . . . . .	 102
 <u>REFERENCES</u> . . . . .	 104
 <u>APPENDIX</u> . . . . .	 107

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## INTRODUCTION

Pain is a prominent symptom in many diseases. Its relief is often a perplexing problem to the practising physician, but paradoxically it plays a useful part in the construction of an exact diagnosis. The latter role for pain may enable the causative process to be located in a single anatomical site when somatic afferent nerves are concerned. Unfortunately the viscera and other deep structures are not endowed with the same sensory precision as is the body wall, and thus visceral pain is more difficult to describe and to locate than somatic pain.

Although pain plays such a major role in many diseases and although it is the concern of the clinician almost every day of his working life, progress towards its better understanding has been left to the endeavours of a few. This is not because of lack of interest but rather because of the difficulties concerned with any form of experimentation on this subject: experiments on animals are properly disallowed and in any event it would be difficult to apply with any precision to man the results so obtained: experiments on patients are ethically unjustified. Progress must therefore be made by deduction from clinical observations and by theorising on those deductions. Such theories may stand for only a short time but so long as the facts are accurately /

accurately recorded then they are available to subsequent investigators. In recording the clinical facts of each case great care must be taken to avoid putting leading questions to the patient and to avoid obscuring the picture with the prejudices of discarded theories; not that these theories were without value in their day - Darwin (1889) wrote:-

"False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness; and when this is done, one path towards error is closed and the road to truth is often at the same time opened."

The testis is a viscus with certain properties which make it an instructive site for the study of visceral pain, and an excellent yardstick against which to test a theory; it has changed its primitive embryological position by its external descent (which may or may not be complete); it has its female counterpart - the ovary remaining in the more primitive site; lastly it is superficial in its final position in the scrotum and therefore easily accessible to stimulation.

In an attempt therefore to study testicular pain, a detailed examination of relevant clinical cases has been undertaken. The conclusions reached have been reviewed in the light of the various theories concerning the mechanism of visceral pain and its reference to other sites. Sir James /

James Mackenzie (1923), in a letter to Kinsella, wrote:-

"In all your observations keep your facts distinct from your interpretation....."

"In taking up this subject you are taking up one of the most instructive and one of the most neglected. It will take you many years before you qualify yourself to be an expert examiner, for you have not only to recognise the symptom but you have to find out the processes that are disturbed to produce that symptom and the agent which originates the disturbance."

This thesis is an attempt to follow Mackenzie's advice.

## REVIEW OF LITERATURE

### Visceral Pain

Pain produced by a noxious stimulus applied to the skin is accurately located by the subject at the precise site of stimulus; furthermore, the site of stimulus is related accurately in space to the rest of the body. Tactile, thermal and visual stimuli are also accurately located and along with pain serve to keep the subject in close touch with his external environment.

On the other hand noxious stimuli applied to the viscera of the body are not accurately located; instead, the brain commonly interprets visceral pain as located vaguely in that part of the body in which the viscus is situated. In some instances however, the pain is interpreted by the brain as originating at a considerable distance from the site of stimulation and, on rare occasions, even on the opposite side of the body. This apparent "error" in the localisation of pain is designated as "referred pain".

Viscera are less richly endowed with afferent (and efferent) nerves than somatic tissues and the difference is not only quantitative but qualitative. Whereas the nerves to somatic tissues contain a considerable proportion of large calibre fibres capable of fast conduction and accurate localisation, the visceral nerves are largely composed /

composed of small calibre fibres which are sparsely distributed and have a high threshold and poor localisation. Visceral afferent nerve fibres run their anatomical course along with the nerves of the sympathetic or parasympathetic nervous system and are sometimes referred to as "sympathetic" afferent fibres: this designation has been objected to on the grounds that the autonomic system is an effector system and that afferent fibres which do not synapse within the system, nor have their cell stations within it, can not properly be called "sympathetic". Such arguments are not fruitful, and since visceral afferent fibres run with the "sympathetic" nerves the term is adjectively correct. W.H. Gaskell in 1885 largely destroyed the conception of the cerebro-spinal and the sympathetic nervous systems as separate entities, although the very nomenclature still in use to-day tends to perpetuate the earlier misconception.

That true visceral pain exists is now generally accepted: it has been described by Ross (1888), Morley (1931), Brown (1942) and Kinsella (1948). It is characterised by being "badly localised, radiating widely, and frequently referred to parts other than those stimulated" (Head et al., 1905). The stimuli necessary to produce pain in a viscus include sudden distension, vigorous contraction and ischaemia of functioning muscle.

Referred Pain /

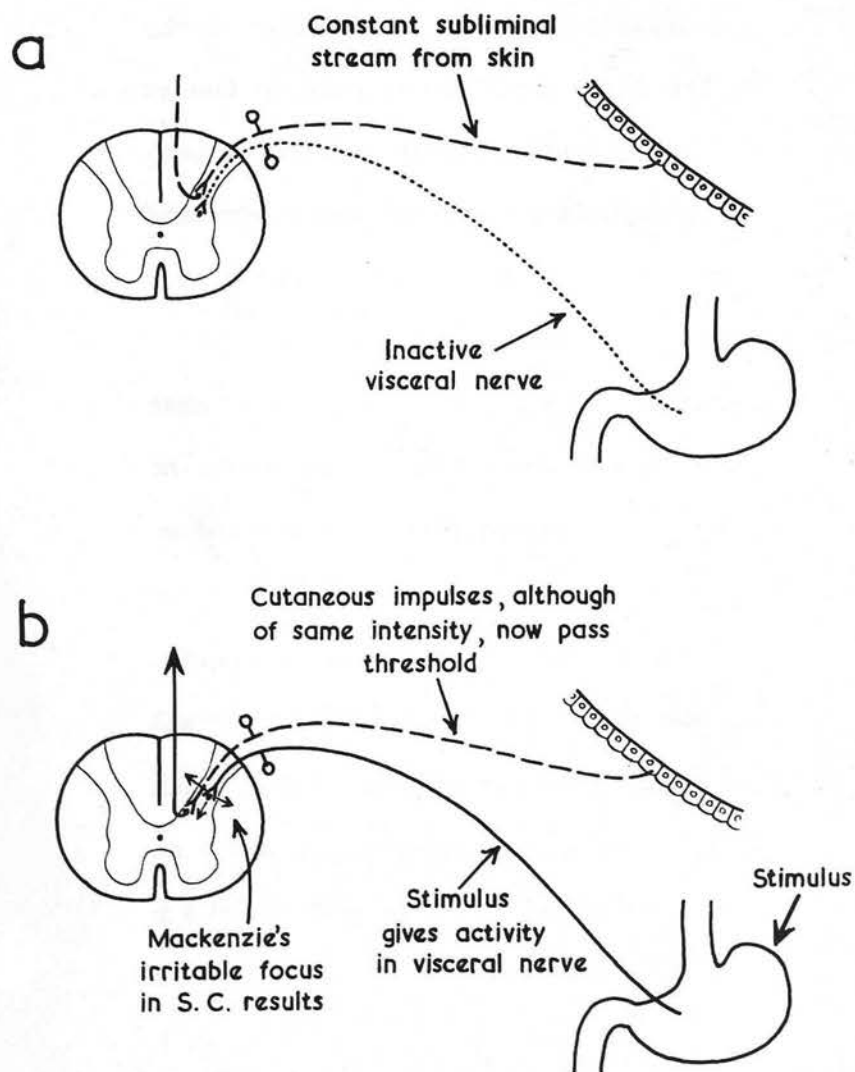


Figure 1.- Mackenzie's Irritable Focus Theory



### Referred Pain

The mechanism of the so-called reference of visceral pain has evoked much discussion. John Hunter first conceived the idea of pain reference when he observed that diseases of the liver could cause pain in the shoulder. Ross (1888) and Mackenzie (1920) gave much thought to the subject, and Mackenzie propounded the theory that an irritable focus was set up within a segment or segments of the spinal cord by visceral afferent stimuli. In turn this so disturbed the somatic secondary neurones that their threshold was lowered and cutaneous impulses, normally sub-threshold, were so enhanced that they reached consciousness (Fig. 1). It was also claimed by Mackenzie that viscerocutaneous, visceromotor and vasomotor reflexes were facilitated, and thus skin hyperaesthesia, muscle guarding and vascular changes were explicable as accompaniments of visceral pain. Mackenzie's theory was later attacked on the ground that anaesthetising the skin in the reference area did not always abolish the pain.

Cohen (1947) circumvented this difficulty by postulating that referred pain is due to the summation of impulses from the periphery (i.e. skin) and impulses from a viscus, together exceeding the threshold for pain: he implied the presence normally of a subliminal stream from the periphery. Cohen's theory was supported by Brown (1948).

Cohen /

Cohen supposed that impulses from the skin and impulses from the viscus converged upon a single spino-thalamic cell body in the spinal cord. Thus impulses from either source, or from both sources together, could excite the discharge of the secondary neurone and so register a response in the sensorium. This explanation was reiterated by Ruch (1949). With this concept, the previous objection to Mackenzie's explanation - and Mackenzie's hypothesis itself - no longer held, since there was no difficulty in explaining why anaesthetisation of the area of reference could give variable results and on occasion might or sometimes might not abolish the pain. In fact anaesthesia would eliminate the pain if the visceral component was subliminal. If the visceral component was of threshold intensity, but only just, and was being enhanced by cutaneous impulses, then anaesthesia would diminish, but not abolish, the pain. Thus Morley's (1931) statement that anaesthetising the shoulder area abolished diaphragmatic pain, and the subsequent emphatic denial by Woollard et al. (1932) of Morley's claim, were both acceptable.

Furthermore, the apparent reference of pain to skin areas no longer present (e.g. the reference of anginal pain to the phantom of an arm previously amputated) could be explained on this basis; the presence of peripheral tissue is not essential for pain reference. For this reason the term "referred pain" has been criticised, since it might be held /



held to imply the existence of a physical point of reference: the alternative term "projection" has been suggested, but has little advantage so long as it is appreciated that the presence or absence of the peripheral area is immaterial to the image held in the brain.

Sinclair et al. (1948) have offered a simpler explanation of pain reference and associated phenomena by postulating an extension of the theory of antidromic impulses. It is generally accepted that sensory axones may give off collaterals to the walls of adjacent blood vessels: nerve impulses passing in the reverse direction to the usual flow (in the case of sensory fibres the flow would normally be centripetal) are termed antidromic and such impulses can induce vasodilatation in the skin supplied by the other branch of the axone or muscular contraction if the other branch is distributed to a muscle. It is believed that these phenomena result from the release of chemical transmitters. Sinclair et al. postulated that one branch of an axone may supply skin or muscle and the other a viscus; visceral afferent impulses may then pass not only into the spinal cord but also in an antidromic fashion along the other branch and thus cause the release of metabolites which in turn lead to the associated phenomena of referred pain, tenderness and muscular rigidity.

Wolff and Hardy (1947), in a detailed discussion concerning visceral pain, concluded that as regards referred /

referred pain:

"Such pain may occur in addition to or in the absence of the true visceral and deep somatic pain described above. It is experienced at a site other than that of stimulation but in tissues supplied by the same or adjacent neural segments. It may occur either with or without associated hyperalgesia and hyperaesthesia.

"(a) Without superficial and/or deep hyperalgesia. In this case pain depends only on the central effects of the spread of excitation of the original noxious impulses to the same and adjacent segments of the cord whence they are relayed to higher centres for perception and interpretation. Injection of procaine into superficial or deep regions of referred pain does not reduce the intensity of pain due to this mechanism.

"(b) With superficial and/or deep hyperalgesia. Referred pain may be accentuated in intensity by virtue of the effects of ordinarily non-noxious stimuli from zones of reference. Impulses from such sources, normally inadequate to produce pain, may do so upon reaching the cord in a segment involved in central spread of excitation. Procaine injected into superficial or deep hyperalgesic structures will abolish this element of the referred pain phenomenon, resulting in more or less reduction of the subject's discomfort, depending on the amount of hyperalgesia."

Whichever theory is chosen to explain pain reference, it is always necessary to presume finally that the brain misinterprets, or wrongly locates, the site of the stimulus. The brain interprets the stimulus as occurring in that area supplied by the same (or adjacent) cord segment from which it commonly receives afferent impulses. The concept of a mental "map of reference" and the concept of segmental skin areas of reference, and the confusion between these two ideas has further complicated discussions concerning the mechanism of referred pain. When a patient points to an area of skin (or more usually indicates the area with the /

the flat of the hand) wherein he feels the pain of his coronary thrombosis, this does not necessarily mean that he considers the pain to be in the skin: indeed he is well aware that this is not the type of pain which accompanies a surface injury such as a burn. The pain of visceral disease has other qualities which differentiate it from somatic pain. Adrian (1947) stated:

"Therefore if a pain message from them [the deep structures] shares some of the pathways from the skin, its place in the map will be referred to the skin."

Brown (1949) disagreed with such a statement and asked:

"Does the physiologist never suffer from deep seated pain?"

Brown's interpretation of Adrian's statements is perhaps too literal since Adrian was discussing the idea of a reference map, and the concept of such a mental map that relates one part of the body to another is a basic premise in our understanding of co-ordinated action.

### Visceral Tenderness

Visceral tenderness is also an accepted fact.

Morley (1931) thought it was due to the sensitive parietal peritoneum being forced into contact with a visceral lesion which caused it to be irritated. Kinsella (1948) believed in true visceral tenderness, the painful impulses originating in the viscus itself: according to him the localisation /

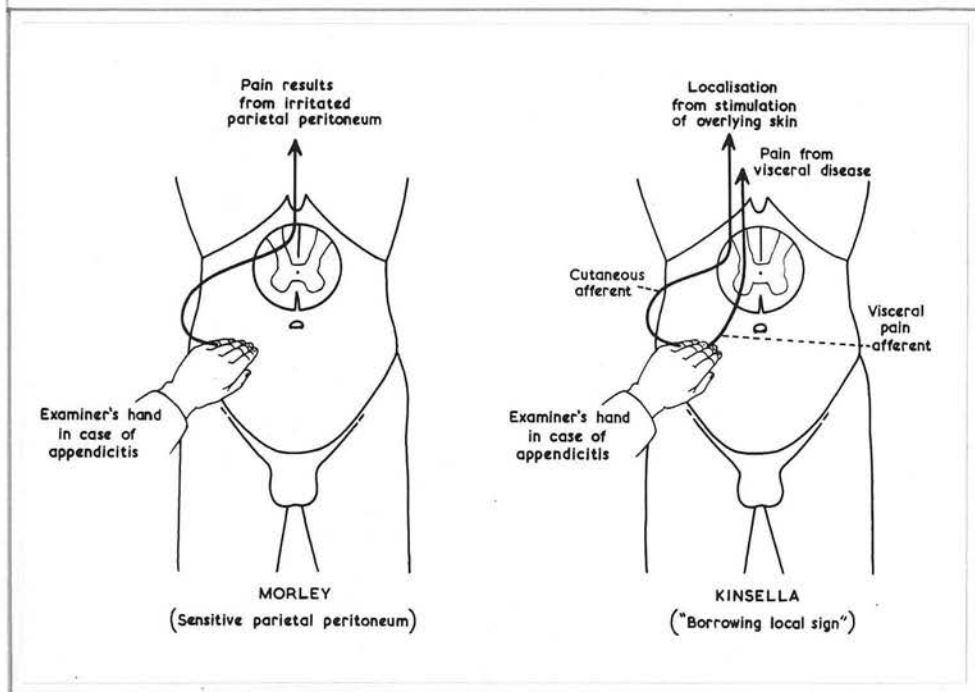


Figure 2.- The Theories of Morley and Kinsella

localisation of the tenderness was due to impulses from the overlying skin which was displaced in the act of eliciting tenderness. Thus the examining hand occasioned two distinct types of afferent impulses, one recording pain from the compressed viscus and the other recording locality depending upon the skin through which the pressure was applied. The term "borrowing local sign" was given to this mechanism (Fig. 2). Morley's claim that the parietal peritoneum was sensitive to an irritant such as an inflamed appendix was later supported by the work of Capps (1932) who found from clinical experiment that light contact of a rough point on the parietal peritoneum produced accurately localised pain. Yet Mackenzie (1920) had recorded:

"the peritoneum (on its serous surface) itself is not sensitive to cutting, scratching, stitching."

The disagreement between Mackenzie's and Capps' findings is of vital importance to the understanding of the mechanism of visceral pain and its reference to other sites. Brown (1949) has recorded his belief concerning the sensitivity of the tunica vaginalis testis along lines similar to those of Capps regarding the general peritoneum, and experiments are detailed later in this thesis which suggest that the tunica vaginalis testis is not itself sensitive. Thus a similar disagreement exists between the present findings and those of Brown and between Mackenzie's /

Mackenzie's findings and those of Capps, and this divergence of opinion will also be discussed later.

### Testicular Pain

Pain is often the earliest symptom of disease in the testis. It is true "visceral" pain, and will be seen later to depend for its production on a sudden rise in tissue pressure within the tunica albuginea. The pain may be accentuated by increase in the pressure from extrinsic sources, e.g. by the increased pressure of the examiner's hand as he palpates the testis, or by pressure of the testis against an adjacent thigh. Where tenderness begins and pain ends is a debatable point in an organ situated in as exposed and vulnerable a position as the testis.

The reference of pain from the testis was noted by Mackenzie (1920) when he described two types of testicular pain, the first accurately localised to the scrotum "via the sensitiveness of the tunica vaginalis testis supplied by the genito-femoral nerve"; the second, the referred pain, localised to the groin and sometimes accompanied by a feeling of faintness. Mackenzie also recorded that both layers of tunica vaginalis testis were sensitive to the stimulus of scratching by a needle point, his experiment being performed on a patient suffering from hydrocele of the tunica vaginalis testis. The fact that his views concerning the sensitivity of the tunica vaginalis testis were /



were antagonistic to his views concerning the sensitivity of the peritoneum generally was recognised by Mackenzie when he stated that the tunica vaginalis testis was the only serous surface of the body to possess a somatic nerve supply.

The investigation of pain arising in the testis is attended by all the difficulties inherent in any study of pain, as well as by the added difficulty that lay patients are unwilling to allow much in the way of experimentation on this part of the body. Yet in many respects the testis is an ideal area for study: it is a viscus whose accessibility facilitates stimulation and it is a viscus which has changed its embryonic position by its external descent.

Woollard and Carmichael (1933) investigated testicular pain by carrying out a series of tests in which graduated weights were placed upon the scrotum supported by the examiner's hand, local anaesthetic having been used to block the posterior scrotal nerves, the ilio-inguinal nerve and the genito-femoral nerve, either separately or together. These experiments are briefly summarised in the Appendix to this thesis. The following conclusions were reached by Woollard and Carmichael:

(1) "In the absence of the posterior scrotal nerves pain is no longer localised to the testis, but to the maximal points of reference in sensory segmental areas.

(2) /

(2) "With the genito-femoral nerve intact, pain is referred from the testis to the maximal points of the first lumbar segment.

(3) "The posterior scrotal and genito-femoral nerves being rendered insensitive, pain from the testis is appreciated in the tenth dorsal segment and is localised to the side stimulated.

(4) "The threshold for the arousing of pain at these situations differs: it is 300 g. for the reference of pain to the testis, 500 g. to the first lumbar segment, and 800 g. or more to the tenth dorsal segment.

(5) "Reference may be obtained from the testicles when the only pathway for sensory impulses is by way of the fibres surrounding the spermatic artery and thus reference is independent of a somatic nerve supply."

These conclusions must be viewed with caution, since the tests were conducted by stimulating the testis through structures themselves sensitive. A warning against such experiments was given by Mackenzie (quoted by Morley, 1931), but in dealing with human subjects the objection is difficult to avoid. Tests subject to the same disadvantage were carried out and are recorded later in this thesis, but, where possible, stimulation was achieved with a needle rather than with blunt pressure applied over a fairly wide sensory zone. The first conclusion of Woollard and Carmichael suggests that if the posterior scrotal nerves were intact, pain would be localised to the scrotum: this is so only if the stimulus is applied through the sentient scrotum and thus "local sign" is borrowed; it is not necessarily so in pathological conditions confined to the testis itself. The second conclusion suggests that an intact /



intact genito-femoral nerve is necessary for pain reference to the groin: the evidence in favour of this is based on their fifth experiment, and on their Spinal Case No. 1 (see Appendix to thesis). In both patients a different interpretation is possible. It is practically impossible to anaesthetise the genito-femoral nerve in the inguinal canal by percutaneous puncture without anaesthetising part (if not all) of the testicular plexus at the same time: if this wider anaesthesia occurred (as it probably did) then the failure of Experiment No. 4 and the varied findings in Experiment No. 5 could be explained on this basis. In the Spinal Case No. 1 not only was the genito-femoral nerve interrupted but no secondary afferent neurone originating lower than T10 could be intact, and, therefore, no impulse could reach the sensorium from groin level: groin reference was inexplicable on any of the theories of referred pain described so far, since in all of them the "confusion" occurs at the segment concerned in the spinal cord. It has already been pointed out that peripheral tissue is immaterial to the mechanism of reference, but all the theories mentioned imply the integrity of the spinal segment concerned.

Woollard and Carmichael were probably biased by their belief that Cushing (1900) had reported that the genital branch of the genito-femoral nerve supplied a hernial sac, cord and testis. In fact, Cushing did not report this, but /

but rather that the scrotal contents were supplied by the ilio-inguinal nerve: his conclusions were drawn from patients in whom the ilio-inguinal nerve had been "cocainized" and it is possible that the anaesthesia involved more than just the ilio-inguinal nerve; because of this, no definite conclusion is justifiable. Mackenzie (1920) had also stated that the genital branch of the genito-femoral nerve supplied the tunica vaginalis testis but gave no proof of this.

Interest in this subject was next stimulated by Brown (1942). In the course of a general discussion on abdominal pain, this author came to the conclusion that:

"Sensations produced in tissues which have been developmentally or artificially displaced from their primary relative positions and which retain only their original innervation are invariably localised in the respective primary relative positions of these tissues....

"True testicular pain will, like ovarian pain, be felt in the loin, since both testis and ovary have migrated from this position."

In a later publication Brown (1949) located pain referred from the testis in a new site - the region of the internal inguinal ring. At first glance, this would appear to conflict with his previous views. However, its accuracy was borne out by a series of experiments conducted by Brown as follows:

Five patients suffering from hydrocele of the testis were /

were investigated. Local anaesthesia of an area of the scrotum was induced and a cannula thrust into the hydrocele cavity. Through the cannula the tunica vaginalis testis was now scratched (both parietal and visceral layers) and found to be sensitive, giving "pain similar to the feeling on squeezing the testis." 30 - 40 ml. of 2% procaine were then instilled into the tunica and time allowed to elapse "until the tunica became insensitive to scratching." 3 ml. of 5% saline were now injected into the body of the testis. This evoked pain which was deeply situated (and not in the skin) and was localised at the internal abdominal ring. The pain was further described as sickening, more intense and harder to bear than pain evoked in the tunica vaginalis.

In his conclusions Brown stated that local intra-scrotal pain is a property of the tunica vaginalis testis and mediated via the genito-femoral nerve - a large calibre somatic nerve - whereas true testicular pain, which is referred to the region of the internal inguinal ring, is a property of autonomic afferent fibres of small calibre. Once again - as with Woollard and Carmichael - the assumption is made that the genito-femoral nerve supplies afferent fibres to the tunica vaginalis testis which is found to be sentient to scratch and to be anaesthetised by procaine.

From /

From the findings of Brown and of Woollard and Carmichael the following facts emerge:

(1) A weight placed on the testis, or a needle scratching the tunica vaginalis testis, results in the perception of pain located in the testis, or rather in that part of the scrotum.

(2) By blocking the posterior scrotal nerves with local anaesthetic this response is abolished. But if the stimulus is sufficient (i.e. the weight is heavy enough) a new response of pain located in the groin is obtained.

(3) If local anaesthetic is instilled into the tunica vaginalis testis, and given time to act, then scratching of the tunica no longer gives a response of local pain. Injection of hypertonic saline into the body of the testis now gives pain located at the deep inguinal ring.

These are the recorded experimental findings. The authors of both papers have made the unsupported assumption that the genito-femoral nerve supplies the tunica vaginalis testis. Woollard and Carmichael attributed this "truth" to Cushing, as described above; Brown attributed it to Mackenzie. Woollard and Carmichael used their assumption to explain the groin reference of pain when the posterior scrotal nerves are blocked because the femoral branch of the genito-femoral nerve supplies that area of skin. Brown used his assumption to explain the localisation of pain /

pain in the scrotum, because parietal peritoneum is said to localise the pain of abdominal visceral disease (e.g. appendicitis) under certain conditions (Morley, 1931).

However, it would seem that the genito-femoral nerve was being endowed with properties that no one had as yet proved it to possess, and, therefore, the above facts (1, 2 and 3) were reconsidered as follows:-

There would appear to be two possible explanations:

(A) The tunica vaginalis is sensitive to scratch and is supplied by the same nerves as the overlying skin, viz. the posterior scrotal nerves.- Thus a posterior scrotal nerve anaesthesia will abolish sensation from the tunica vaginalis testis as well as from overlying skin: or instillation of local anaesthetic into tunica vaginalis testis will abolish the response to scratch.

(B) The tunica vaginalis testis is not sensitive to scratch and plays no part in the localisation of pain to the scrotum.- It seems not unlikely that the needle used to scratch the tunica vaginalis testis (via the cannula) disturbs the overlying skin of the scrotum; borrowed reference or local signature (Kinsella) may therefore occur and the patient will be perfectly aware of the site of the stimulus (but not because of any sentient properties of the tunica itself). Furthermore, the needle point has only to penetrate tunica vaginalis to stimulate pain nerve fibres running to the skin of the scrotum; in this case, the stimulus /

stimulus of "prick" is being applied from within the skin and not, as is usual, from without. Instillation of procaine into the hydrocoele sac was found by Brown to abolish sensation from the tunica: this could similarly be explained by the diffusion of the local anaesthetic agent through the tunica to affect the overlying cutaneous sensory nerves. (In this connection it will also be noted that the dose of anaesthetic agent used, viz. 30 - 40 ml. of 2% procaine, is a very large one).

Only by accepting one of these two (A, B) explanations can the findings that the two separate procedures (posterior scrotal block, and local anaesthesia of a needle track down to the testis with later "anaesthetisation" of tunica vaginalis) both result in abolition of the local response be explained.

The second explanation (B) implies that Brown has fallen prey to the danger which Mackenzie warned against, and whose warning Brown (1956) reiterated, namely, the danger of attempting to draw conclusions from stimulation of a tissue through structures themselves sensitive.

Whichever explanation is accepted it will be seen that neither invokes the aid of a genito-femoral nerve, and there seems to be no good evidence for supposing that any part of this nerve supplies the tunica vaginalis testis.



THE ANATOMY OF THE SENSORY NERVES SUPPLYING  
TESTIS AND SCROTUM

Theoretically sensory nerves could reach the testis and scrotum from several sources:

- (1) Through afferent nerves accompanying the sympathetic plexus surrounding the testicular artery - "sympathetic afferents."
- (2) Through afferent nerves accompanying the vas deferens from the hypo-gastric plexus.
- (3) Through the genital branch of the genito-femoral nerve.
- (4) Through the posterior scrotal nerves.
- (5) Through the perineal branch of the posterior cutaneous nerve of the thigh.
- (6) Through the lowest branches of the ilio-inguinal nerve.

Unless a secondary innervation is acquired after the (external) descent of the testis, then the posterior scrotal nerves, the perineal branch of the posterior cutaneous nerve of the thigh and the ilio-inguinal nerve could not be expected to supply the testis itself. Furthermore, this (external) descent is, in embryological terms, a late occurrence, taking place long after the nerve supply of other viscera is fixed: indeed in some patients the testis may /

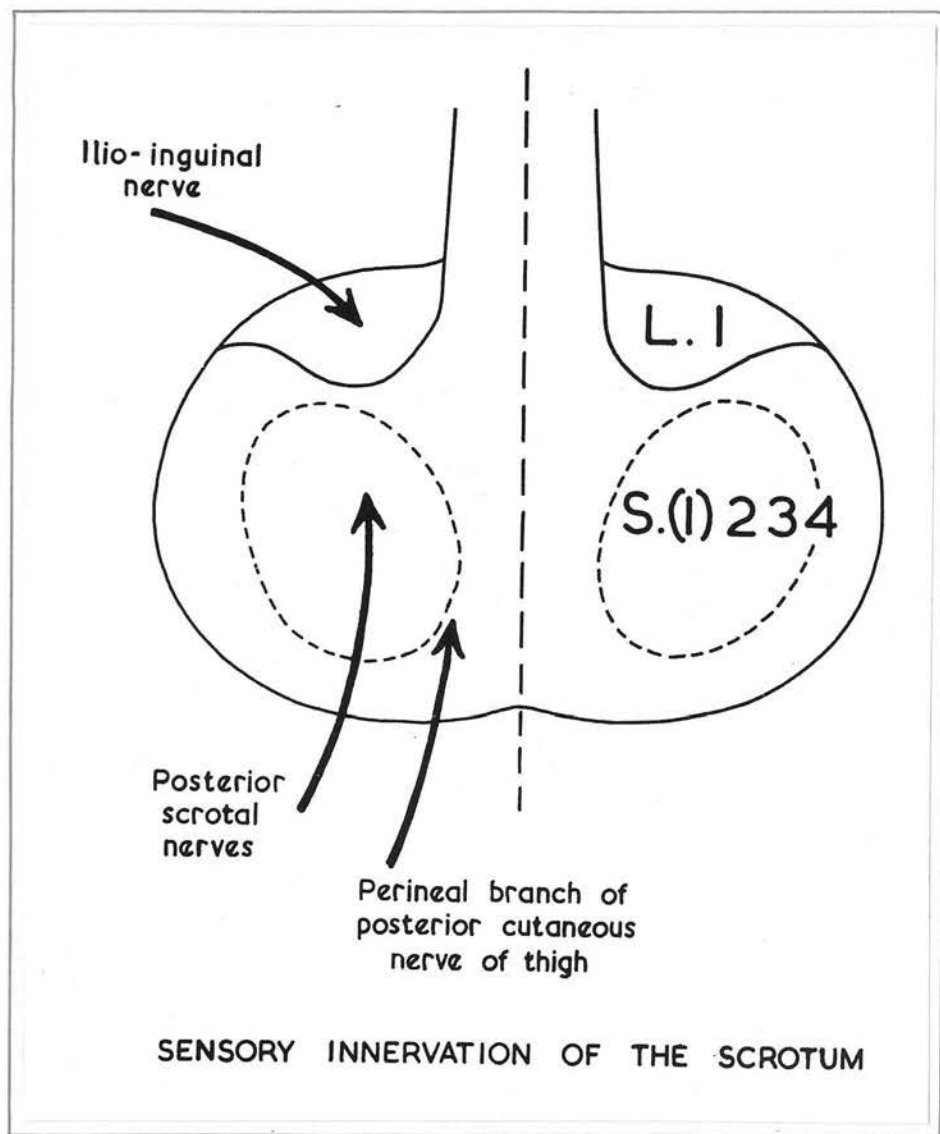


Figure 3



may remain undescended but still endowed with afferent nervous connections.

### The Scrotum

According to Cunningham's Text-Book of Anatomy (1943), the sensory innervation of the scrotum is threefold:

(i) The ilio-inguinal nerve, derived from first lumbar spinal segment (L1), is distributed to the upper and anterior portion of the scrotum.

(ii) The posterior scrotal nerves, derived from the pudendal nerve and, therefore, ultimately from the second, third and fourth sacral (S2, 3 and 4) spinal segments, are distributed to the posterior part of the scrotum.

(iii) The perineal branch of the posterior cutaneous nerve of thigh derived from S1, 2 and 3 spinal segments, is distributed as are the posterior scrotal nerves.

This pattern of innervation is agreed to by Jamieson (1942) and by Johnston (1948). Thus, in terms of spinal segments the anterior portion of the scrotum is innervated from L1 segment, and the posterior portion from S2, 3 and 4 segments (and possibly also S1 segment) (Fig. 3).

### The Testis /

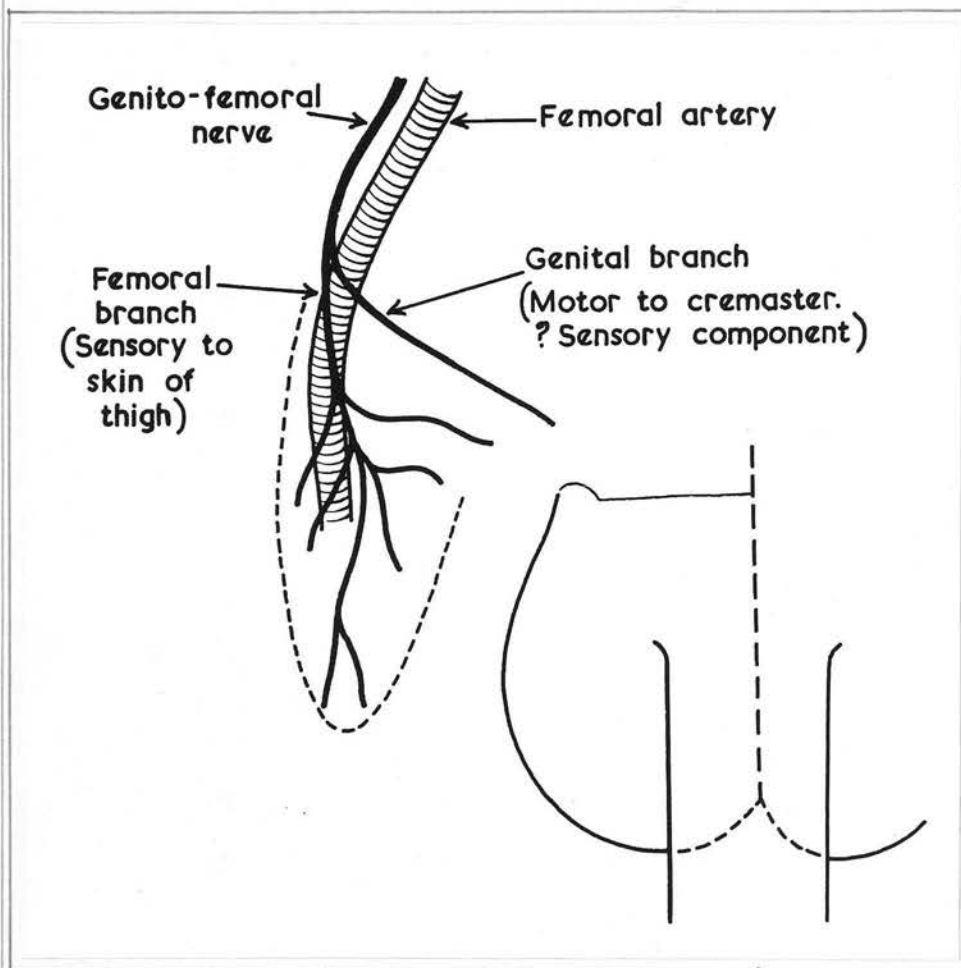


Figure 4.- The Distribution of the Genito-Femoral Nerve

### The Testis

The Genito-Femoral Nerve.- It is stated in various text-books (e.g. Jamieson, 1942; Cunningham, 1943; Johnston, 1948; Gray, 1954) that the genital branch of the genito-femoral nerve provides the motor supply to the cremaster muscle. This can be demonstrated by division or local anaesthetic blockade of the nerve. What is not clear is its sensory distribution, if any (Fig. 4). Gray, Cunningham and Jamieson state that a few filaments of the nerve are distributed to the skin of the scrotum; Johnston states that the genital branch of this nerve supplies a branch to the tunica vaginalis testis.

It seems reasonable to regard the genito-femoral nerve as being in series with the segmental nerves of the trunk, the ilio-inguinal nerve being its immediate fellow. If it is accepted that these segmental series supply the peritoneum (Capps), then the genito-femoral nerve (spinal segments L1 and 2), pulled out of line by the descent of its area of distribution, would similarly supply the cremaster muscle (the lowest loops of transversus abdominis and obliquus internus abdominis) and its associated peritoneum (the tunica vaginalis testis). As yet there is no definite proof that such is in fact the case.

The Sympathetic Afferents Accompanying the Testicular Artery or the Vas Deferens.- Jamieson and Johnston are in agreement in describing testicular afferent nerves as originating from the aortic and renal plexuses, connecting ultimately /

ultimately in the case of the testis with the tenth thoracic spinal segment, and in the case of the epididymis with the eleventh and twelfth thoracic and the first lumbar segments. Martin (writing in Cunningham's Text-Book of Anatomy) refers only to the tenth thoracic segment in this respect with regard to both testis and epididymis.

According to Morley (1931), the testis is innervated by L1 and L2, but Pottenger (1944) and Underwood (1950) favour T10, 11 and 12 by way of the gonadic plexus (the term "gonadic plexus" referring to the nerve plexus around the testicular artery). White (1943, 1955) refers to the work of Woollard and Carmichael and ascribes, as does Kuntz (1929), testicular innervation to T10; but it is thought (Hinsey, 1943) that there may be considerable variation in the levels at which afferent fibres from the testis enter the spinal cord.

Hovelacque (1927), in his monumental work, described the testicular (spermatic) plexus as follows:

The spermatic nerves have a fairly constant origin, deriving roots from the renal and from the inter-mesenteric plexuses. The roots from the renal plexus arise near its origin, or from its medial part, and are two or three in number. They pass downwards usually in front of the renal artery and behind the vein to join the spermatic artery a short distance below its origin. The branches from the inter-mesenteric nerves are variable both in source and /

and number: the higher of these branches originates just below the renal vessels, the lower some 3 or 4 cm. lower down; these branches run laterally to join the spermatic artery where they form the spermatic plexus around the vessel. This plexus is also very variable in actual form, and is distributed to the testis only, no branches going to the epididymis.

Hovelacque does not specify the actual segmental levels of any of the branches of the spermatic plexus. Mitchell (1953) describes further sources for the testicular plexus. He divides the testicular nerves into three groups as follows:

(a) Superior Gonadic Nerves: arise from the renal and inter-mesenteric plexuses. They may also receive additional filaments from the 2nd or 3rd lumbar splanchnic nerves, the coeliac plexus or the superior mesenteric plexus. These nerves join the spermatic artery and supply testis but not epididymis.

(b) Middle Gonadic Nerves: arise by a series of fine rootlets from the superior hypo-gastric plexus or from the upper ends of the homolateral hypo-gastric nerves, and are often blended with the middle ureteric group and may communicate with the genito-femoral nerve. These nerves run laterally to join the spermatic vessels and the group (a) above. The middle gonadic nerves are distributed in the male mainly or entirely to the epididymis and the beginning /

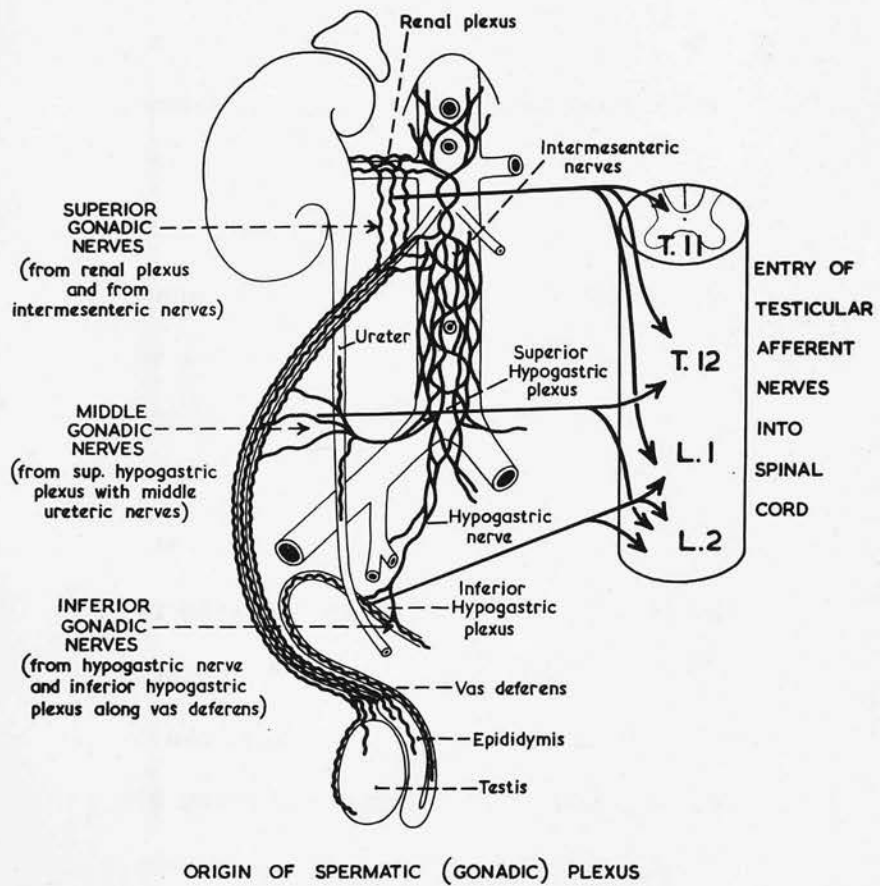


Figure 5

beginning of the vas.

(c) Inferior Gonadic Nerves: arise from nerve loops around the lower end of the ureter and the adjacent hypogastric plexus. These nerves supply vas and epididymis.

It will be seen that the superior gonadic nerves of Mitchell's description correspond with the spermatic plexus described by Hovelacque: Mitchell thus agrees that the testis itself derives its nerve supply from, or transmits its afferents through, the renal and inter-mesenteric plexuses. His diagrams illustrate the nerves with great clarity, and the sites of entry of the "chief visceral afferent pathways" are noted, but the testis is not mentioned specifically: renal afferent segments are given as T12 (11) to L1 (2), the figures in brackets referring to the possible range of variation: ureteric afferent segments are given as L1 and L2. Thus by deduction the testicular afferent segments should lie somewhere between T11 and L2 (Fig. 5). Like Hinsey (1943), Mitchell also stresses the possibility of variation of spinal segments concerned and the possibility of extra routes being present in individual cases.



### THE DEVELOPMENT OF THE TESTIS

The testis, like the ovary, develops from the germinal epithelium on and adjacent to the genital ridge, as early as the thirty-third day of development. The genital ridge extends from the sixth thoracic to the second sacral body segments. However, at no one time is the ridge present throughout this entire length because as it develops caudally it atrophies cranially.

In this manner the sex gland develops and appears to move caudally, and it was formerly taught that its "internal descent" was occasioned by the gubernaculum testis pulling on the lower pole of the developing gland. By the seventh month of development the gonad lies adjacent to the internal inguinal ring. In the last ten weeks of development the testis accomplishes its "external descent" accompanied by the processus vaginalis testis through the inguinal canal to enter the scrotum.

If the gonad was indeed pulled downwards along the posterior abdominal wall away from the segments of its origin it would be expected to drag with it its original nerve supply from these segments; referred pain from the gonad therefore might be expected to be related to the original higher segments, rather than to be referred to the vicinity of the groin as Brown (1949) claimed. However, it has been suggested that the testis (or ovary) does not undergo /



undergo internal descent in such a way, and that the process of gonadal development consists of progressive atrophy of the cranial end of the gland as the caudal pole forms. Developing in this manner, the gonad eventually comes to lie "at the boundary between abdomen and pelvis and close to the groin" (Felix, 1912; Keith, 1933; Arey, 1954). Thus by the tenth week of development it is lying close to the groin and has developed from the portion of the genital ridge in that vicinity; under these circumstances its nerve supply would presumably have originated in that vicinity and thus it would be reasonable to find referred testicular pain in the same area.

The external descent of the testis does not occur until long after its nerve supply has been established, and should not therefore alter the nerve supply because in this descent it carries coverings, tunica, and blood supply from its more primitive level at the groin.

CLINICAL EVIDENCE CONCERNING TESTICULAR PAIN

In order to investigate the problem of testicular pain associated with various pathological states, a series of 46 patients were closely questioned regarding their symptomatology, and the site, or sites of pain. When their histories were taken, no leading questions were asked. When pain was complained of the patient was asked to point accurately to its site, and the area was then appropriately marked on the skin, later to be transferred to a diagram and/or photograph. Each patient was asked to describe his pain in detail.

The following are brief notes of the case histories of these patients.

I. PAIN RESULTING FROM DISEASE OF THE TESTIS

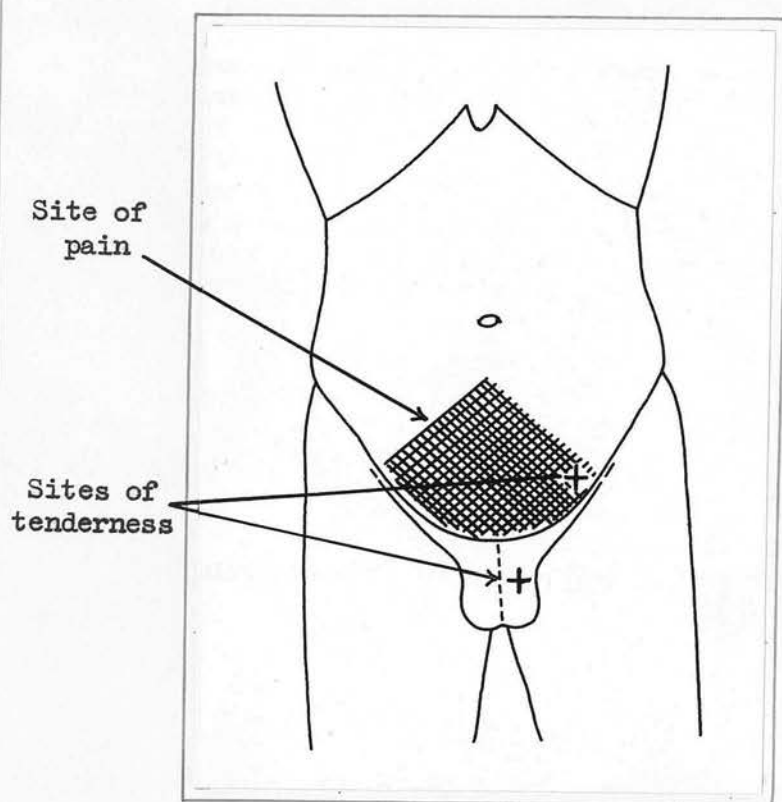


Figure 6

## Torsion of Testis

Case 1.- Male, aged 13 years.

### History

Seventy-two hours before admission to hospital this boy was struck in the central abdomen. Several hours later he developed lower abdominal pain (see Fig. 6) and vomited. Shortly thereafter he noted the left side of his scrotum to be swollen. Over the subsequent 48 hours the abdominal pain worsened, then disappeared and the left scrotum became tender. On admission the boy insisted that there was no pain in his scrotum unless he was touched there.

### Examination

On examination the scrotum was found to be dusky, red and swollen on the left side especially. There was tenderness over the left internal inguinal ring (see Fig. 6).

### Operation

An intra-vaginal torsion was found of the left testis which was gangrenous and was therefore excised.

### Points of Interest

- (1) The site of pain in the lower abdomen.
- (2) The tenderness at the internal inguinal ring.
- (3) The distinction made by the patient between pain and tenderness in the scrotum.
- (4) The early occurrence of abdominal pain in the clinical picture.

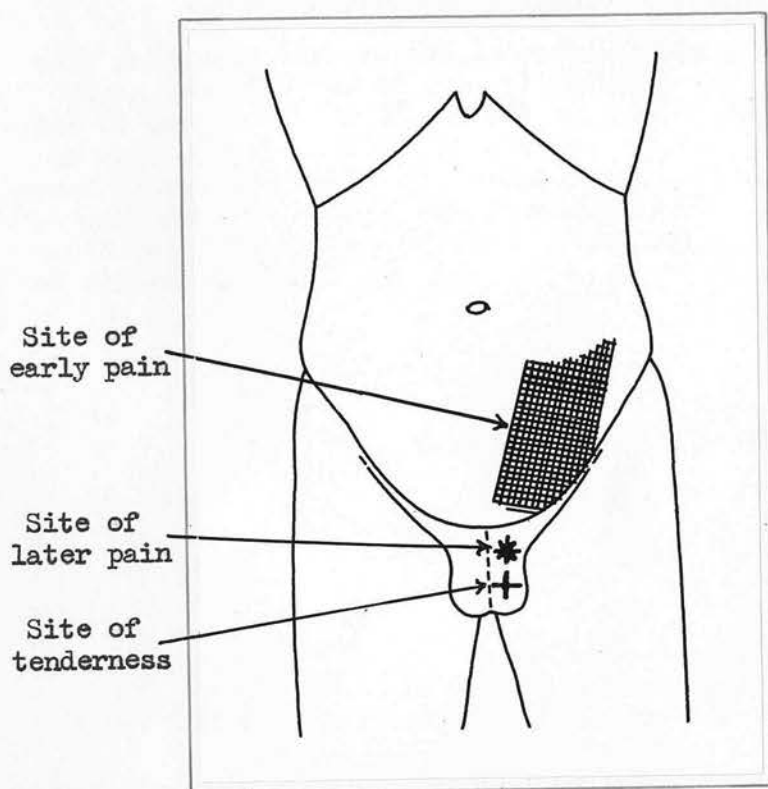


Figure 7



### Torsion of Testis

Case 2.- Male, aged 21 years.

#### History

About  $1\frac{1}{2}$  hours before admission this patient developed pain, colicky in type, in the left iliac fossa. This pain increased in severity and was later accompanied by nausea. When he attempted to relieve the pain by defaecation he noticed that his left testis was swollen and tender. Shortly thereafter he developed severe pain in the testis (see Fig. 7).

#### Examination

On examination the left testis was found to be swollen and the left side of the scrotum to be tender.

#### Operation

Operation was carried out  $2\frac{1}{2}$  hours after onset of the first symptom and showed torsion of the left testis. Reduction of the torsion (one turn) restored the blood supply to the testis.

#### Points of Interest

- (1) The site of the pain in the left iliac fossa.
- (2) The later occurrence of tenderness in the scrotum.
- (3) The attempt by the patient to relieve his pain by defaecation, his symptoms presumably suggesting to him that he suffered a bowel upset.
- (4) The late occurrence of pain in the scrotum (as distinct from tenderness).



Figure 8

### Torsion of Testis

Case 3.- Male, aged 15 years.

#### History

Seven days before admission the patient received a blow to the left testis which thereafter became painful, swollen and tender: these symptoms settled with rest in bed.

On the day of admission the left side of the scrotum swelled and became painful when he moved, but so long as he lay still he found his pain was severe but was located in his "stomach" and accompanied by vomiting (see Fig. 8).

#### Examination

On examination acute tenderness and swelling of left side of scrotum were found.

#### Operation

Operation showed torsion of the testis, with a return of blood supply after reduction.

#### Points of Interest

- (1) The site of the true pain in the left iliac fossa.
- (2) The site of tenderness and the description of tenderness as "pain when he moved."

1 = Pain of first complaint

2 = Subsequent pain (developing 6 hours later than 1)

3 = Pain occurring 9 months later

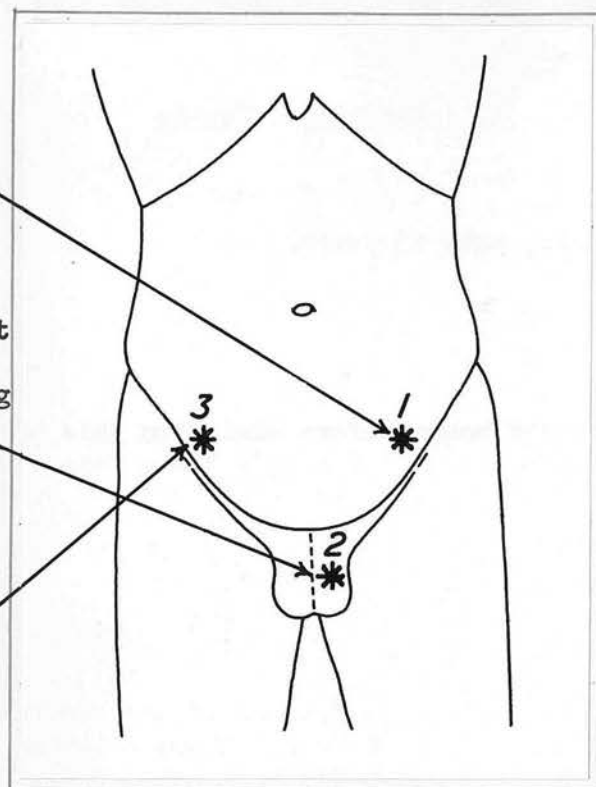


Figure 9

Twisted pedicle

Gangrenous testis

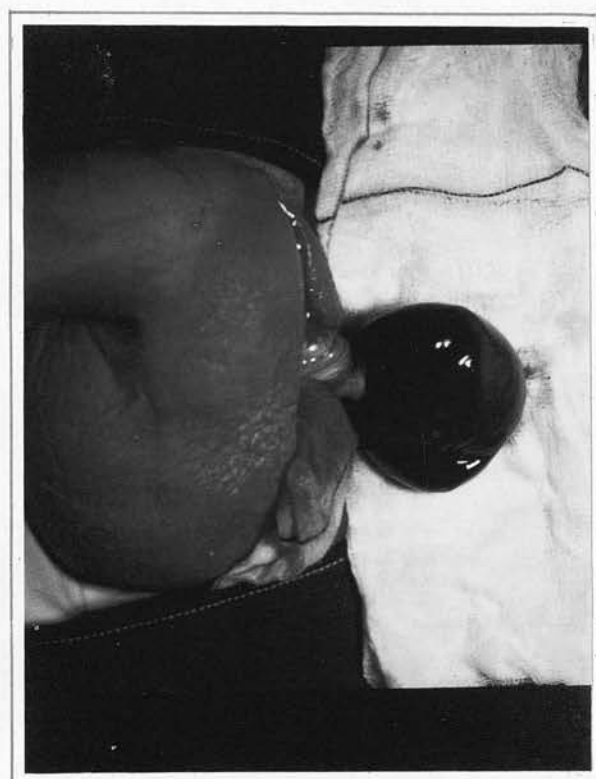


Figure 10

### Torsion of Testis

Case 4.- Male, aged 15 years.

#### History

Forty-eight hours before admission this patient developed aching pain in the left iliac fossa. Six hours later he noted the left side of his scrotum to be swollen and tender.

#### Examination

On examination the left side of the scrotum was found to be reddened, oedematous and extremely tender. Abdominal examination was negative (Fig. 9).

#### Operation

Operation was carried out through the oedematous scrotum. The testis was found to be twisted about its vessels and was (one complete rotation) and to be gangrenous. Orchidectomy was performed (Fig. 10).

#### Progress

Nine months later the patient developed a similar aching pain in the right iliac fossa. On this account operative fixation of the right testis was carried out as prophylaxis against torsion.

#### Points of Interest

(1) The site of the early pain.

(2) The similarity of the symptoms later developing on the other side.

### Torsion of Testis

Case 5.- Male, aged 18 years.

#### History

There was a history of sudden onset of severe pain around the umbilicus radiating into the right side of scrotum and accompanied by vomiting.

#### Examination

Examination revealed tenderness in the right iliac fossa and the right testis was found to be tender and fixed at the external inguinal ring.

#### Operation

Operation showed torsion of the right testis, and reduction resulted in recovery of blood supply. Operative fixation was carried out.

#### Points of Interest

- (1) The site of the pain around the umbilicus.
- (2) The site of tenderness.



Twisted  
pedicle



Figure 11

Pedicle  
untwisted



Figure 12

### Torsion of Testis

Case 6.- Male, aged 11 years.

#### History

Five hours before operative treatment was undertaken this boy developed central suprapubic pain, sharp in nature and constant in severity. At the same time he noted that the right side of the scrotum had become swollen but only later did he develop discomfort in the scrotum.

Because the pain was mistaken to be "stomach-ache" medical advice was not sought earlier in the illness.

#### Examination

Examination revealed a tender, swollen testis in the right side of the scrotum.

#### Operation

The right testis was found to be twisted  $2\frac{1}{2}$  times inside the tunica vaginalis testis about an axis formed by the mesentery between the vas deferens and the back of the epididymis. The testis was found to be viable after reduction of torsion and fixation was therefore carried out (Figs. 11 and 12).

#### Progress

The right testis remained of satisfactory size 6 months later and operative fixation of the contra-lateral testis was undertaken. The same broad mesentery between epididymis and vas deferens was found at operation on the other side and permitted easy torsion of the testis.

Points /

Points of Interest

- (1) The site of pain in the abdomen.
- (2) The mis-diagnosis occasioned by the site of pain.
- (3) The axis about which torsion occurred on the right side and the similar developmental anomaly on the left side.

- \* = Site of pain
- + = Site of tenderness
- ++ = Site of tenderness over upper pole of testis

Gridiron scar

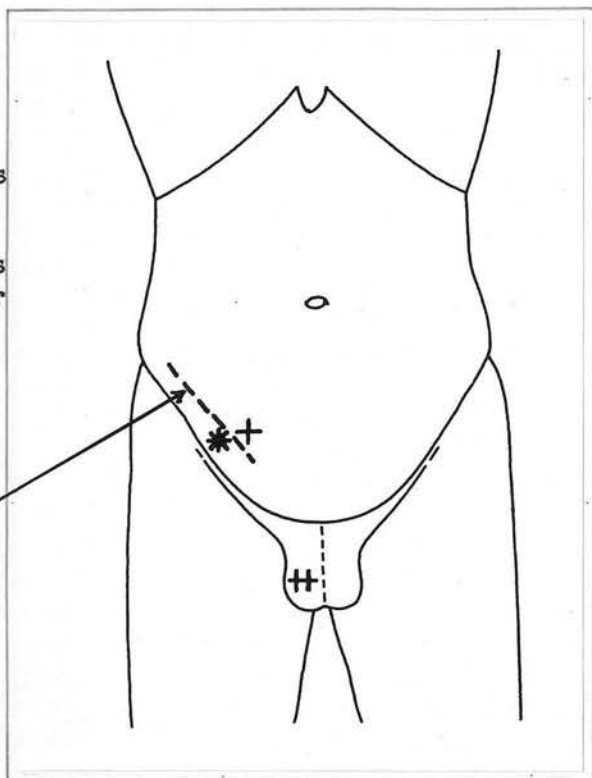


Figure 13

### Torsion of Hydatid of Morgagni

Case 7.- Male, aged 11 years.

#### History

The patient was first admitted to hospital in November, 1954 with a history of abdominal pain and vomiting. The pain was situated below the umbilicus and later moved to the right iliac fossa.

A diagnosis of appendicitis was made but the appendix was not inflamed at operation nor was there any evidence of mesenteric adenitis. Microscopical examination of the excised appendix confirmed its normality.

Four months later - in April, 1955 - the boy was re-admitted with a history of abdominal pain, the site of the pain being in the right iliac fossa.

#### Examination (April, 1955)

The child was asked to point to the site or sites of pain (see Fig. 13). Tenderness was noted immediately deep to the scar of the gridiron appendicectomy wound. Marked tenderness was noted at the upper pole of the right testis and a diagnosis of torsion of the hydatid of Morgagni was made.

#### Operation

Operation confirmed the diagnosis and the infarcted hydatid was excised.

#### Points of Interest

- (1) The site of pain in the right iliac fossa.
- (2) The initial diagnostic error and appendicectomy.
- (3) The recurrence of pain and its relief by excision of the hydatid.

### Torsion of Hydatid of Morgagni

Case 8.- Male, aged 11 years.

#### History

This boy had suffered from spasms of pain in the left groin for the past three years. The attacks occurred at least every fourteen days and repeated examination had been negative. There were no other relevant symptoms.

#### Examination

Examination revealed a tender nodule at the upper pole of the left testis and a diagnosis of recurrent torsion of a testicular appendage was made.

#### Operation

Operation confirmed the presence of two hydatids at the upper pole of the left testis and both had long pedicles. Both were excised.

#### Progress

The patient was followed up for three months and had no recurrence of symptoms, whereas previously his pain had been recurring at intervals of (at most) two weeks.

#### Points of Interest

- (1) The site of the pain in the groin.
- (2) The relief of symptoms by excision of the hydatids.



## Torsion of Hydatid of Morgagni

Case 9.- Male, aged 10 years.

### History

This boy was struck on the scrotum the day before admission. Following this trauma he developed pain in the right groin and found his right testis to be swollen and tender and he vomited.

### Examination

Examination showed the right side of the scrotum to be swollen, reddened and tender, the swelling being translucent.

### Operation

At operation a gangrenous testicular appendage was found and excised. A reactive hydrocoele was present.

### Progress

Progress was satisfactory.

### Note

The summary of the case history stated "pain and swelling in right scrotum following trauma" despite the recorded history of "pain in the right groin."

### Points of Interest

- (1) The site of pain in the groin.
- (2) The misrepresentation of the site of pain in the case summary, presumably because it seems reasonable to locate pain beside the causative swelling.

### Torsion of Hydatid of Morgagni

Case 10.- Male, aged 5 years.

#### History

This boy complained of constant pain in the right groin for 24 hours before admission. There were no other symptoms.

#### Examination

Examination revealed the right side of scrotum to be reddened and tender and there was a tender nodule at the upper pole of the testis.

#### Operation

Operation confirmed the diagnosis of torsion of the hydatid of Morgagni.

#### Note

As in Case 9, despite the recorded history of pain in the groin, the case was summarised as "abdominal" pain. It is not clear from the notes whether true abdominal pain was present or whether this was a misrepresentation of the facts.

#### Point of Interest

The site of the pain in the groin and perhaps in the abdomen.

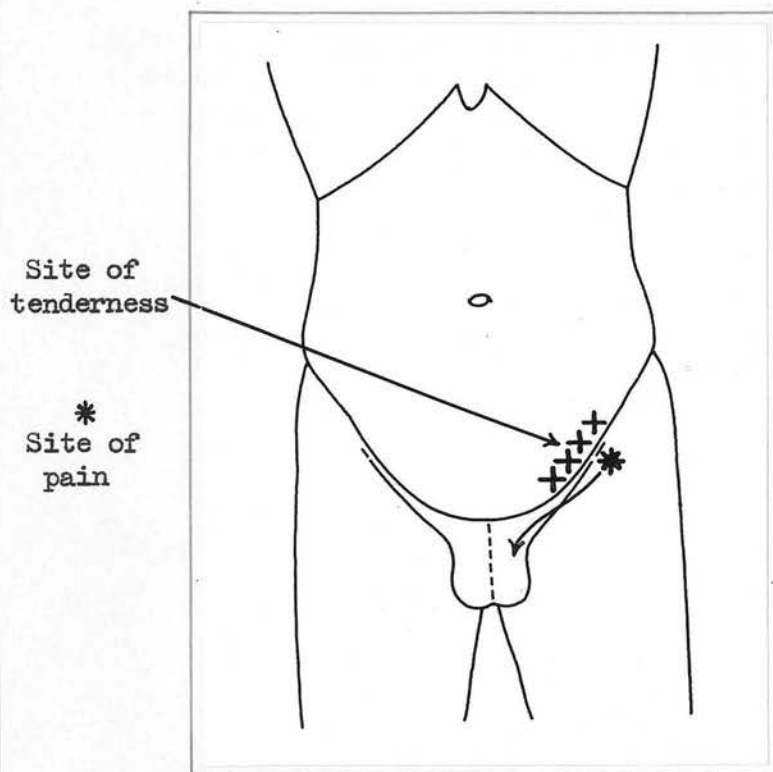


Figure 14

### Torsion of Hydatid of Morgagni

Case 11.- Male, aged 13 years.

#### History

Twenty-four hours before admission, while playing cricket, this boy developed pain in the left groin radiating down to the scrotum. The pain was associated with severe nausea and anorexia but no other symptoms.

#### Examination

Examination revealed tenderness just above the inguinal ligament on the left side and tenderness in the left side of scrotum (see Fig. 14).

#### Operation

Operation revealed torsion of the hydatid of Morgagni.

#### Points of Interest

- (1) The site of the pain in the groin.
- (2) The presence of tenderness above the inguinal ligament.

Torsion of Hydatid of Morgagni

Case 12.- Male, aged 13 years.

History

For eight hours before admission this boy had suffered severe pain in the right side of the abdomen and in the right testis.

Examination

Examination showed acute tenderness in the right epididymis but no tenderness in the abdomen.

Progress

No operation was performed and the symptoms and signs settled rapidly. A provisional diagnosis of spontaneous reduction of a twisted hydatid of Morgagni was made.

Points of Interest

(1) The site of the pain in the abdomen and in the testis.

(2) The absence of abdominal tenderness; the presence of a tender epididymis.

(3) The possibility therefore of confusion between testicular tenderness and "pain in the testis."

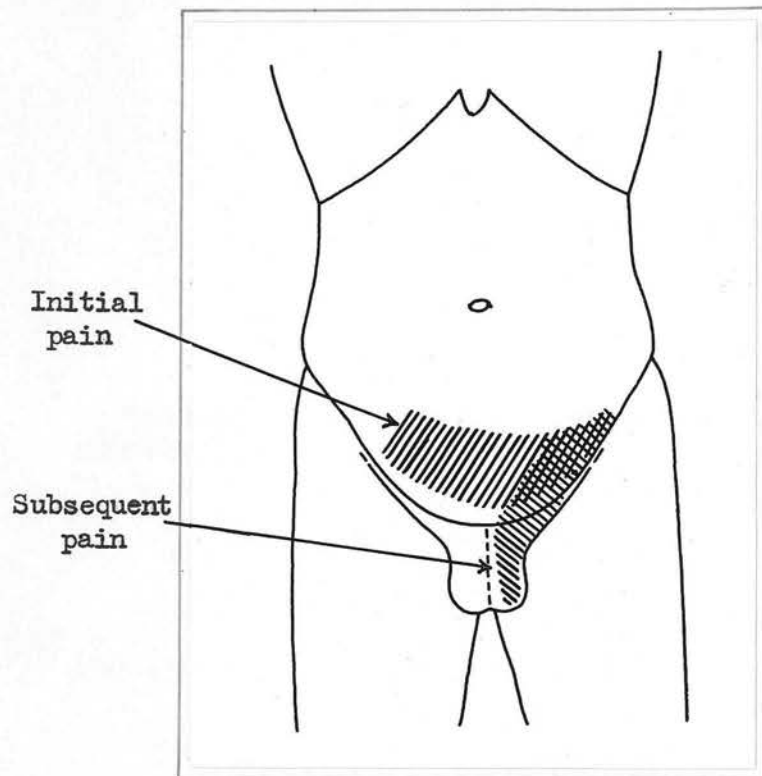
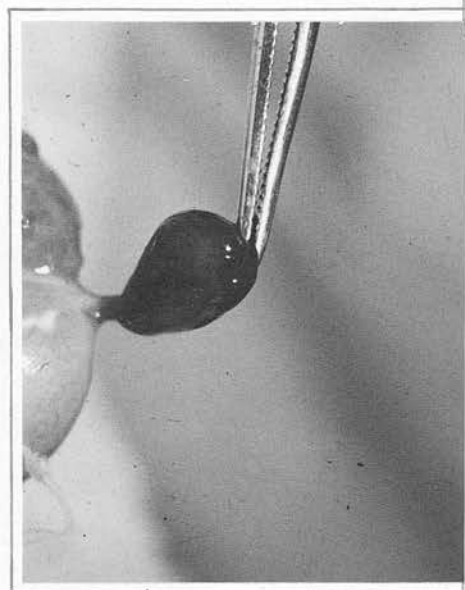


Figure 15



Figures 16 and 17.- Gangrenous Hydatid of Morgagni



### Torsion of Hydatid of Morgagni

Case 13.- Male, aged 18 years.

#### History

Several days before admission this patient complained of lower abdominal pain. Three days before admission he developed pain in the left lower abdomen, the left groin and the left side of the scrotum. The scrotal pain was present only when the patient moved or touched the part (see Fig. 15).

#### Examination

Examination showed acute tenderness and swelling of the left side of scrotum.

#### Operation

Operation confirmed a gangrenous hydatid of Morgagni which was excised: the epididymis was also found to be swollen and congested (see Figs. 16 and 17).

#### Pathology

Pathological examination confirmed the excised lesion to be an infarcted appendix testis.

#### Points of Interest

- (1) The site of initial pain in the lower abdomen.
- (2) The site of secondary pain in left lower abdomen and groin.
- (3) The confusion between pain and tenderness in the left side of scrotum.

Site of  
initial  
pain

Note no  
initial  
pain in  
scrotum

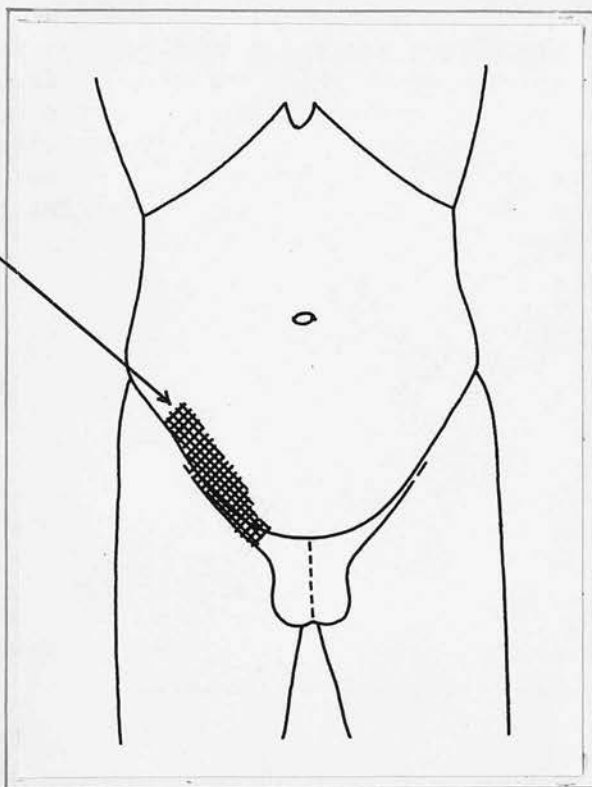


Figure 18

## Seminoma of Testis

Case 14.- Male, aged 30 years.

### History

Four weeks before admission this patient received a blow on the scrotum after which the right side of the scrotum swelled but was not painful. On the evening of admission the patient "strained himself at skittles" and developed aching pain in the right iliac fossa and right groin. Later the right testis became painful for the first time (Fig. 18).

### Examination

On examination the right side of the scrotum was found to be enlarged, reddened and acutely tender.

### Operation

At operation an infarcted and infected seminoma of the right testis was found and excised.

### Point of Interest

The site of the initial pain in the right iliac fossa and right groin.

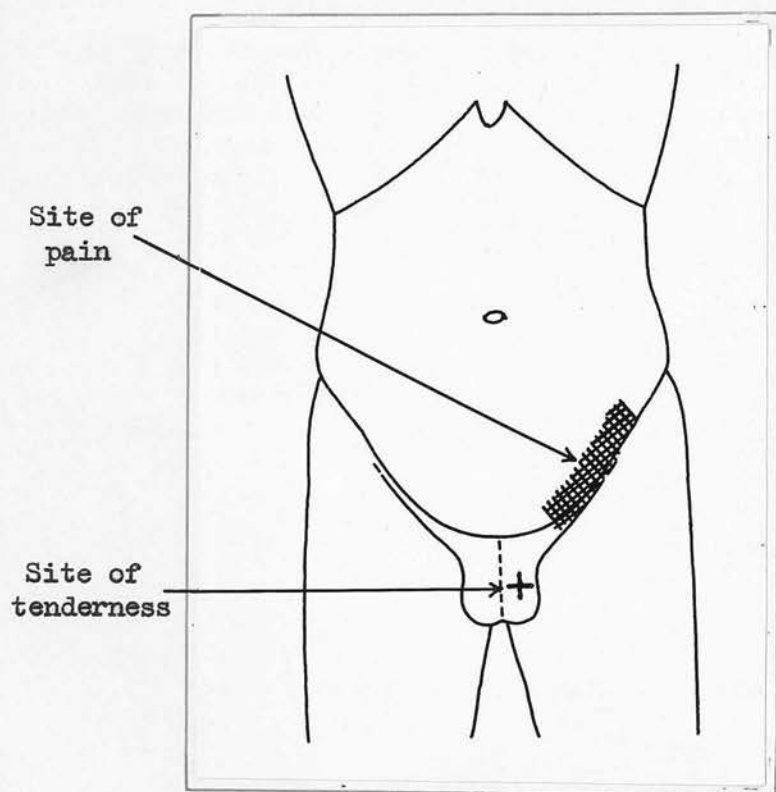


Figure 19

### Epididymo-orchitis

Case 15.- Male, aged 54 years.

#### History

This patient complained of lower abdominal pain and frequency of micturition for about one month. The pain had been situated in the left lower abdomen and groin. On the day before admission he had noted discomfort and tenderness in the left testis. Although his symptoms were interpreted by the house surgeon initially as "pain in the testis", on later questioning, and on being asked to elaborate his pain especially, he was quite insistent that he felt only tenderness in the affected testis and that it troubled him only when he touched the testis, or moved, or sat down: the pain remained in the region of the inguinal ligament. The patient volunteered this information without prompting (Fig. 19).

#### Examination

Examination showed tenderness and swelling of the left testis. Urine culture showed B. coli infection and a diagnosis of epididymo-orchitis was made.

#### Progress

No operation was performed because conservative measures were followed by resolution of the condition.

#### Points of Interest

- (1) The site of pain along the inguinal ligament.
- (2) The discrimination between pain in the lower abdomen and tenderness in the testis.

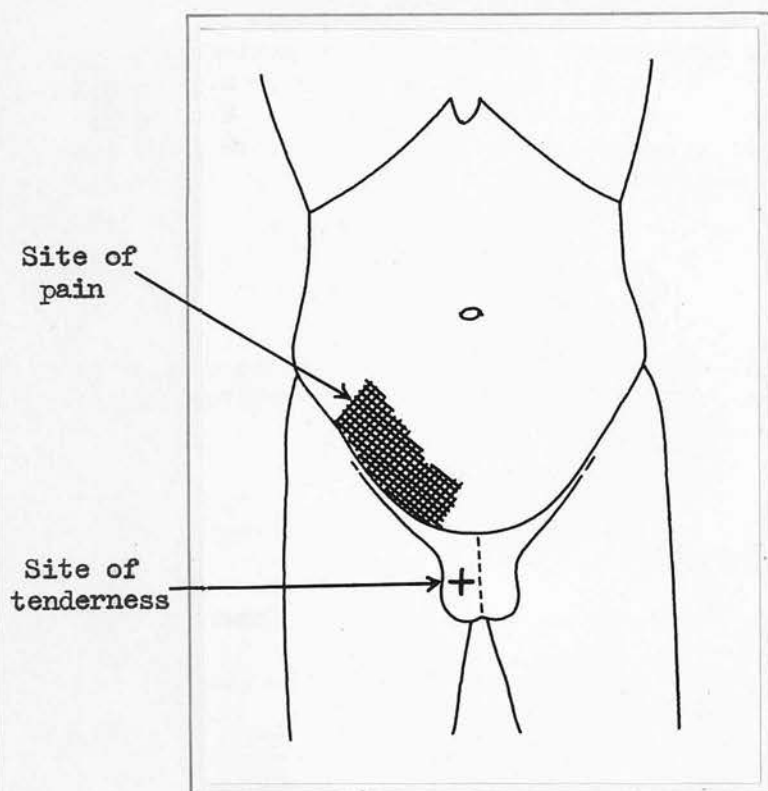


Figure 20

### Epididymo-orchitis

Case 16.- Male, aged 59 years.

#### History

For five days before admission this patient had complained of severe pain in the right lower abdomen and also of a tender and swollen right testis. The patient was quite clear concerning the differing sites of the pain and tenderness (Fig. 20).

#### Examination

Examination and subsequent investigation confirmed a diagnosis of epididymo-orchitis which resolved following treatment with antibiotics.

#### Points of Interest

- (1) The site of pain in the lower abdomen.
- (2) The distinction made between pain (in the abdomen) and tenderness (in the testis).



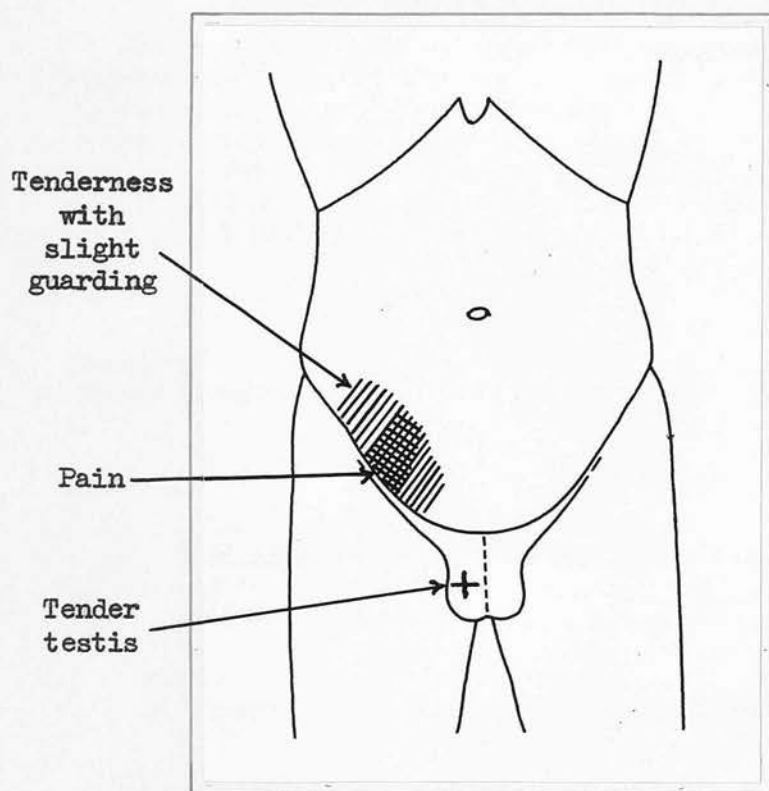


Figure 21

### Testicular Pain of Doubtful Aetiology

Case 17.- Male, aged 47 years.

#### History (recorded by admitting surgeon)

Three hours before admission this patient developed pain low in the right iliac fossa. The patient also noted that the right side of the scrotum swelled and became tender and he vomited once. He suffered from long-standing frequency of micturition and gave a history that four weeks previously, following trauma to the right testis, he developed pain in the right iliac fossa and tenderness in the right side of the scrotum.

#### History (recorded by the admitting house surgeon)

"Wakened this morning with pain in the right testicle, radiating up into the right groin to about one inch below the iliac crest. The pain became unbearable about six hours after its onset and he vomited several times. He has no urinary symptoms. Five weeks ago the patient experienced a sudden pain in his testis radiating up into his right groin."

(The differences between this history and the former history are underlined).

#### Examination

Examination showed tenderness, redness and swelling in the right side of scrotum and tenderness and slight guarding in the right iliac fossa, maximal just above the internal inguinal ring (Fig. 21).

#### Operation

Exploration of the testis showed appearances suggestive of epididymo-orchitis but bacteriological culture /

culture of both hydrocoele fluid and urine was negative and subsequent investigation failed to substantiate the diagnosis further. The possibility of a spontaneously reduced torsion appears just as likely a diagnosis.

#### Points of Interest

- (1) The marked discrepancy between the two histories, the first taken by a doctor interested in the subject, the latter, not.
- (2) The site of pain in the iliac fossa.
- (3) The interpretation of tenderness as pain by the second doctor taking the history.

### Epididymo-orchitis

Case 18.- Male, aged 15 years.

#### History

On the day before admission this patient developed pain in the left iliac fossa and subsequently vomited. Twelve hours later he developed severe pain and swelling in the left side of the scrotum. The boy was a diabetic and had had a creamy urethral discharge for two years.

#### Examination

Examination showed redness, swelling and tenderness in the left side of the scrotum.

#### Progress

A diagnosis of epididymo-orchitis was made after further investigation and the condition resolved under antibiotic therapy.

#### Points of Interest

- (1) The site of the pain in the iliac fossa.
- (2) The delay of twelve hours before pain and swelling appeared in the scrotum.

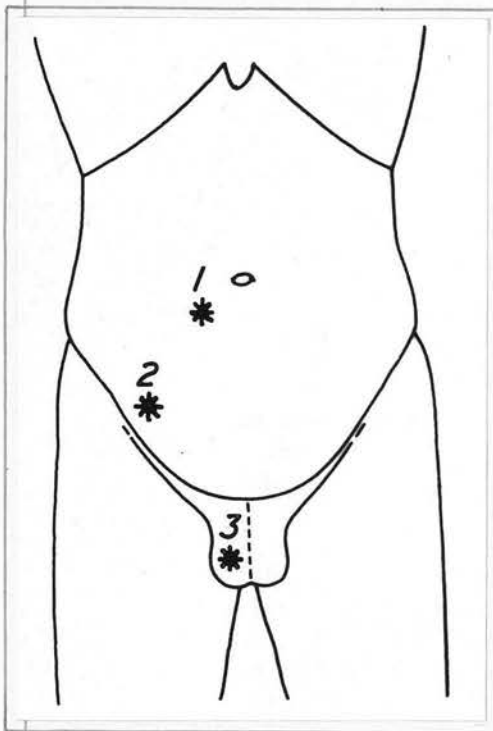


Figure 22

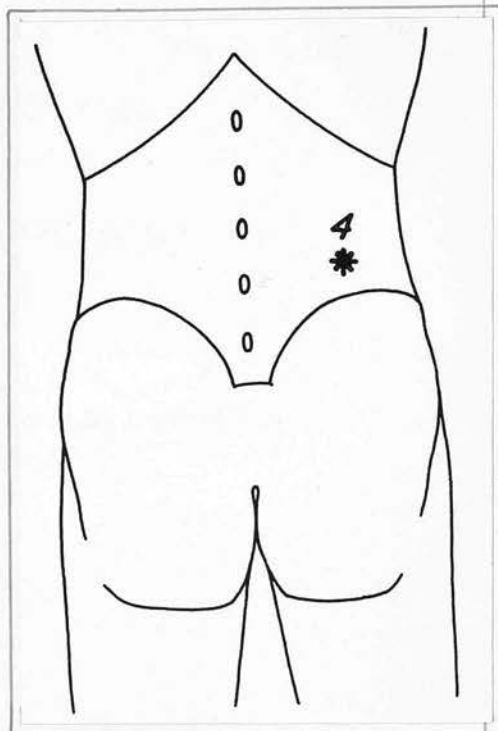


Figure 23

1.  
Site of  
abdominal  
pain

2.  
Site of  
later  
abdominal  
pain

3.  
Site of  
pain  
following  
trauma



4.  
Site of  
back pain  
(associated  
with later  
abdominal  
pain)

Figure 24

### Haematoma of Testis

Case 19.- Male, aged 32 years.

#### History

Two weeks before admission this patient was struck a severe blow on the right side of the scrotum. Acute pain and swelling of the right side of scrotum resulted but resolved after a few days with rest in bed.

Four days before admission the patient developed pain in the right iliac fossa. On the day of admission pain developed lower in the right iliac fossa and also in his back just above the right iliac crest. The abdominal pain was described as very severe and "deep" in its situation (Figs. 22, 23 and 24).

#### Examination

Examination showed the right side of the scrotum to be discoloured with a resolving haematoma, to be swollen and to be indurated. Light pressure with the thumb and fingers on the contents of the right side of the scrotum caused the patient to experience pain in the right iliac fossa just above the internal inguinal ring.

#### Progress

A diagnosis of traumatic haematocoele of the right testis was made and the patient was treated conservatively. By the next day the pain had resolved. On examination six weeks later the right testis was noted to be shrinking in size and appeared atrophic; the patient was symptom-free.

#### Points of Interest

- (1) The occurrence of local pain in the scrotum following direct trauma to overlying skin as well as testis.
- (2) The later pain, and its site in the abdomen.
- (3) The later occurrence of pain in the back.
- (4) The severity of the pain and its description as "deep".

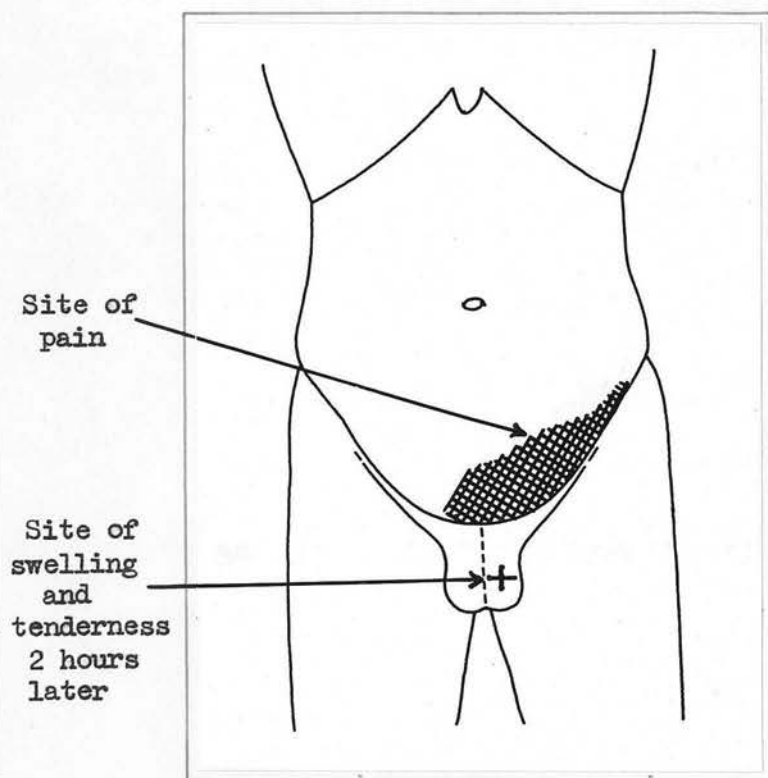


Figure 25



## Rupture of Testis

Case 20.- Male, aged 18 years.

### History

On the day of admission this patient was playing football and received a blow from an opponent's knee. As a result of this blow the patient collapsed, vomited and developed abdominal pain. Because of the collapse he could not remember the exact site of the blow. After going to bed the patient awakened two hours later and found that he still had lower abdominal pain, but also that the left testis was swollen and exquisitely tender. Even then he had no pain in the testis so long as he lay still (Fig. 25).

### Examination

Examination showed the left side of scrotum to be grossly swollen and acutely tender. Bruising of the left scrotum and of the perineum was evident.

### Operation

Operation revealed that the testis had been ruptured transversely near its upper pole. Haemostasis was secured and the testis repaired.

### Progress

Progress was satisfactory.

### Points of Interest

- (1) The site of the pain in the abdomen.
- (2) The collapse and vomiting associated with the pain.
- (3) The site of the tenderness (but the absence of pain) in the scrotum.



### Haemorrhage into Epididymis

Case 21.- Male, aged 45 years.

#### History

Six weeks before admission this patient developed swelling of the left side of the scrotum; there was no history of trauma. This incident caused only minor discomfort "but no pain", and he did not seek medical advice, the swelling gradually subsiding.

Three days before admission the patient experienced pain which puzzled him because it was deep and aching and did not seem to be in the expected place; this pain was situated in the right iliac fossa.

#### Examination

Examination revealed some thickening around the testis, suspicious of malignancy and on this account exploration was undertaken.

#### Operation

Operation revealed a normal testis but a small hydrocoele and a discoloured epididymis. Biopsy subsequently confirmed that the discolouration of the epididymis was due to a resolving haematoma.

#### Points of Interest

- (1) The site of the pain in the abdomen.
- (2) The late onset of the pain.
- (3) The realisation by the patient that the pain "did not seem to be in the right place."

- T = Sites of testes
- O = Internal inguinal rings
- /// = Site of pain
- ⊗ = Sites of maximum pain

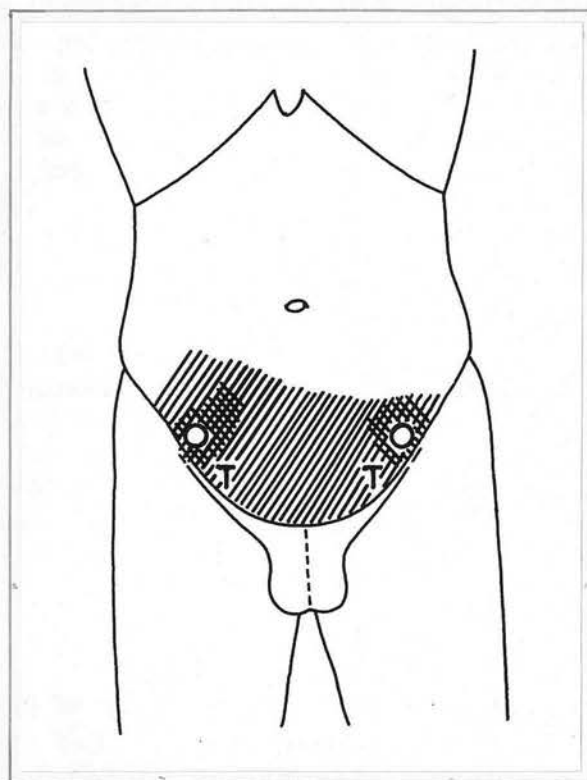


Figure 26

## Bilateral Superficial Inguinal Ectopic Testes

Case 22.- Male, aged 19 years.

### History

For the past two or three years this boy had suffered from attacks of abdominal pain not associated with nausea or vomiting. The pain had been situated centrally in the lower abdomen or in one or other iliac fossa. On this account he consulted his doctor.

### Examination

Examination showed bilateral superficial inguinal ectopic testes in an otherwise normally developed male. Neither testis could be made to enter the scrotum, and both lay lateral to and outside the external inguinal ring. No other cause could be found to account for the abdominal pain.

### Operation

Operation confirmed the ectopic sites of both testes (Fig. 26).

### Point of Interest

The site of the pain in the abdomen, although the testes were displaced from their normal site and even from their normal line of descent.

Site of  
pain from  
R.U.D.T.  
pre-  
operatively

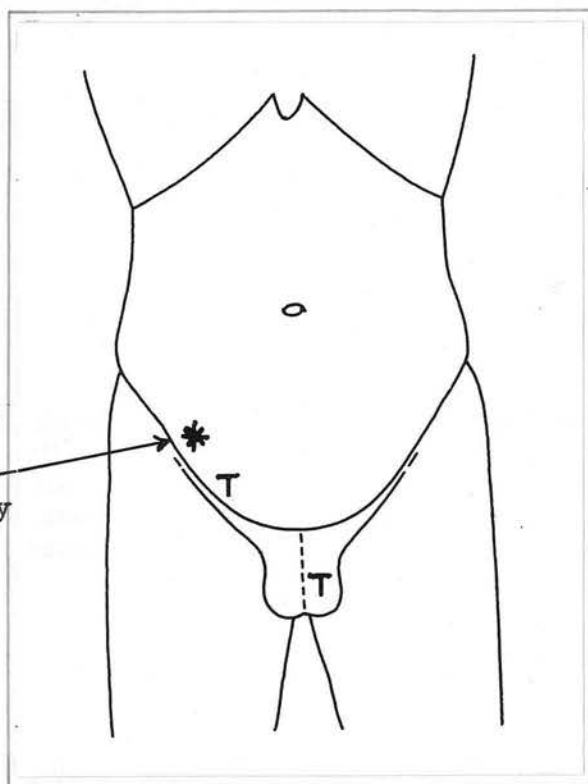


Figure 27.- Undescended R. testis

Sites of  
pain  
resulting  
from  
pressure  
on either  
testis  
post-  
operatively

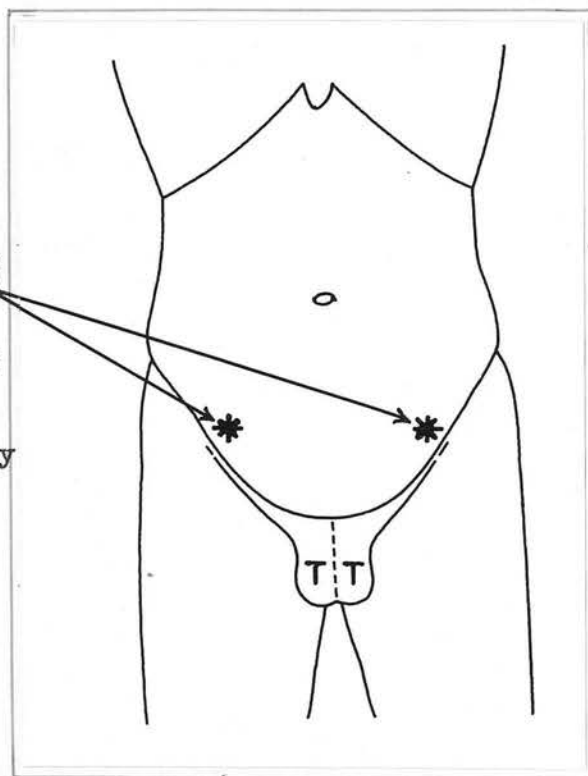


Figure 28.- Both testes in scrotum

### Undescended Testis

Case 23.- Male, aged 37 years.

#### History

The right testis of this patient had been undescended until it was operated on at the age of 35. He had sought treatment for it because it caused him pain in the lower right abdomen (Fig. 27). Operative placement of the testis in the scrotum cured his symptoms. The patient was married and had children.

#### Examination

Examination revealed both testes to be small but equal in size. Pressure on either testis caused the patient pain which he located without suggestion or prompting at the internal inguinal ring (Fig. 28).

#### Points of Interest

(1) The site of the original pain low in the right iliac fossa.

(2) The site of the pain, resulting from pressure on either testis, in the iliac fossa.

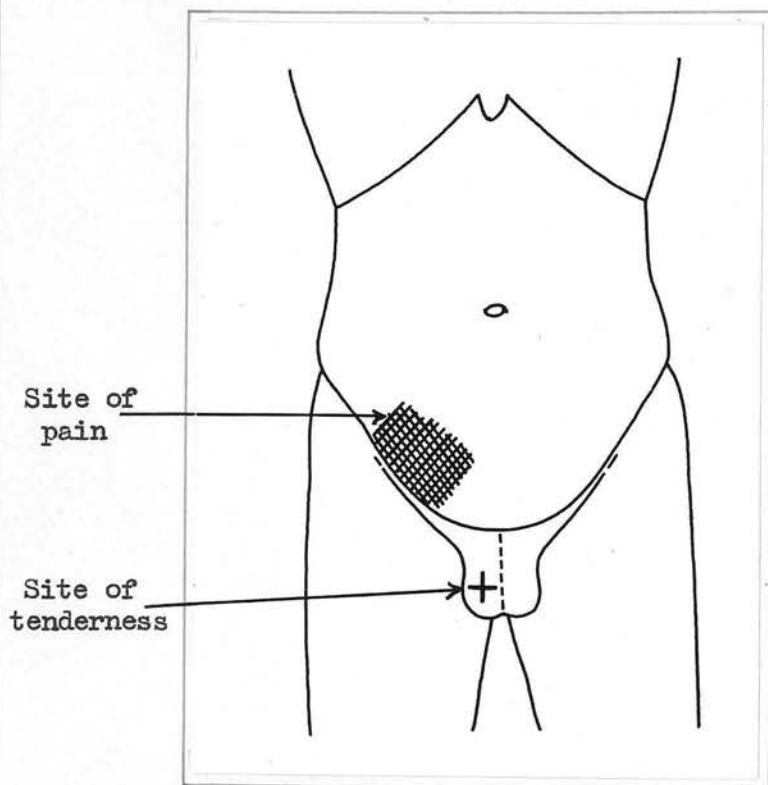


Figure 29

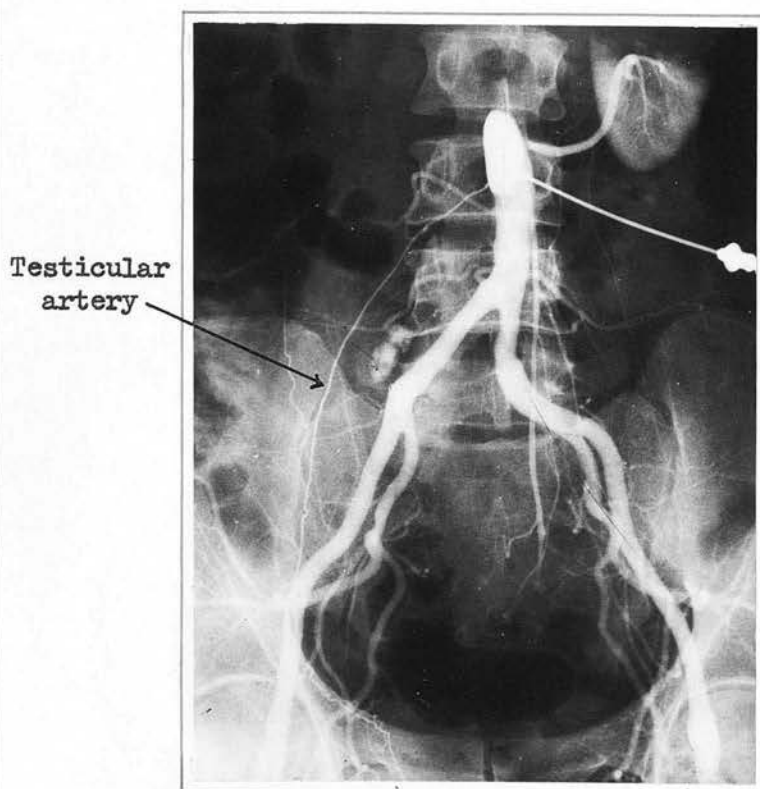


Figure 30



### Infarction of Testis

Case 24.- Male, aged 51 years.

#### History

This patient was under investigation for intermittent claudication; percutaneous translumbar aortography was performed. Ten hours later he complained of abdominal pain (Fig. 29) and was examined by a house surgeon who could not find any cause for the pain. Fifteen hours after aortography he still suffered from abdominal pain but now noted pain in the right side of the scrotum when he touched or moved the part, but not when he lay still. He described the pain in the abdomen as being of the "bowel type". A diagnosis of infarction of the testis resulting from aortography was now made.

The aortogram showed filling of the right testicular artery (Fig. 30) and testicular atrophy followed this incident.

#### Points of Interest

- (1) The site of the pain in the abdomen.
- (2) The diagnostic delay because of the site of the pain.
- (3) The radiological evidence of filling of the right (but not the left) testicular artery.
- (4) The delay of several hours before localising symptoms developed in the scrotum.

II. TESTICULAR PAIN SENSATION  
IN VARIOUS CLINICAL STATES

Site of  
pain

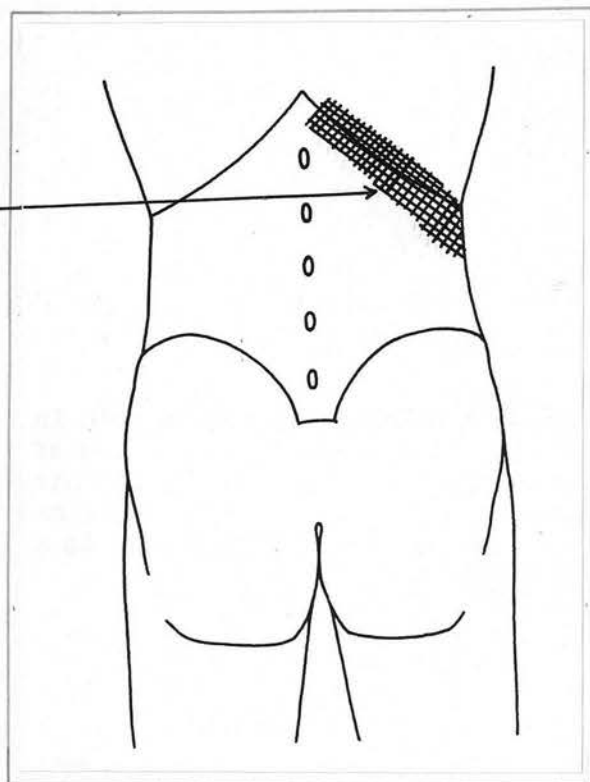


Figure 31

Pain  
radiating  
down into  
testis

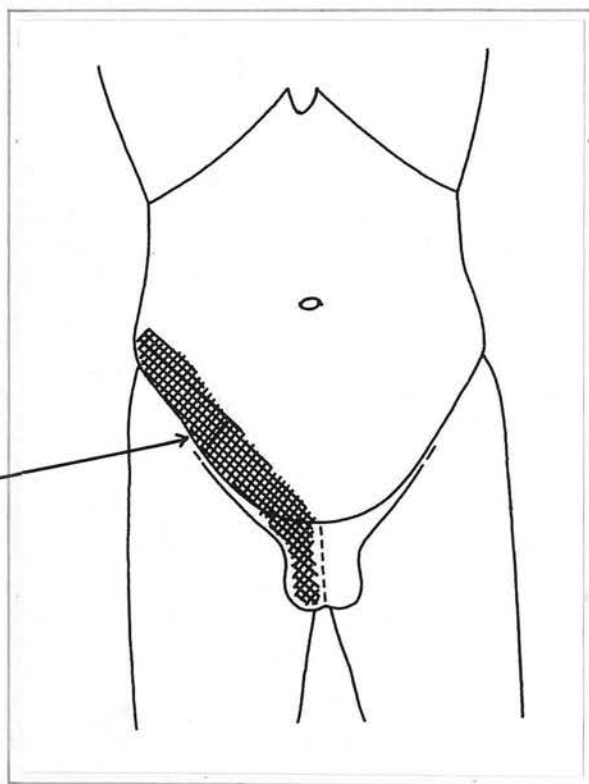


Figure 32

Spinal Osteomyelitis with Testicular Pain

Case 25.- Male, aged 58 years.

History

This patient complained of severe pain in the back, right side of chest and right upper abdomen of several days' duration. At the onset of symptoms his pain had radiated from his back into the right flank and right lower abdomen and thence into the right side of scrotum (Figs. 31 and 32).

Progress

Subsequent investigation failed to reveal any abnormality in the testis or in the genito-urinary system but his symptoms were found to be due to a focus of osteomyelitis affecting the inter-vertebral disc between T8 and T9 vertebrae with cavitation of the right side of the disc and the adjacent vertebral bodies.

Point of Interest

The pain which this patient experienced in the right side of the scrotum would appear to have been caused by reference along testicular afferent paths entering the spinal cord at T8 or T9 level probably via T8/9 sympathetic ganglia.

Patient undergoing Right Nephrectomy

Case 26.- Male, aged 15 years.

Summary of Case

This boy underwent right nephrectomy for hydro-nephrosis. Both before and after operation testicular sensation was estimated to determine whether it was in any way altered by disruption of the renal (sympathetic) plexus.

Tests of testicular pain sensation were performed by the method of Woollard and Carmichael (see Appendix) by placing a scale pan on the scrotum while supporting the testis in the scrotum on the examiner's hand; weights were then added to the pan.

Findings

Pre-operative Test 1

Right Testis		Left Testis
700 g.	Nil	Nil
800 g.	Nil	Pain just above medial half of inguinal ligament.
1000 g.	Aching pain at internal inguinal ring.	Pain just above medial half of inguinal ligament.

Pre-operative /

Pre-operative Test 2

Right Testis		Left Testis
700 g.	Nil	Pain at internal inguinal ring.
800 g.	Pain at internal inguinal ring.	Pain at internal inguinal ring.
1000 g.	Pain at internal inguinal ring and in right testis.	Pain +++ at internal inguinal ring.

Note

The patient was asked why his pain was in the region of the internal inguinal ring when it was his testis which was being pressed and he was asked if he was sure it was so; he replied that he did not know why it was so but that he was in no doubt as to the site of his pain.

Post-operative Test 1

Right Testis		Left Testis
500 g.	Nil	Nil
600 g.	Pain in testis.	Nil
700 g.	-	Pain in testis.

Post-operative Test 2

Right Testis		Left Testis
700 g.	Pain in testis.	Nil
800 g.	-	Pain in testis.

Points /

### Points of Interest

- (1) Right nephrectomy did not appear to have made any real difference to the threshold for pain.
- (2) The reference of pain changed between the pre-operative and post-operative tests but since this change was bilateral it could not be attributed to the operation.

### Conclusion

Nephrectomy did not alter sensation in the testis.

### Discussion

At operation I saw all the lumbar sympathetic chains were intact. The sympathetic ganglia seemed not very large, but below the right one of the right and left probably at levels L1 and L2 ganglia. The volume of the sympathetic chain seemed to be similar, probably L1 and L2 were the sympathetic of the chain between the two ganglia.

### References

Right Testis		Left Testis
500 g.	511	500
1000 g.	511	511
500 g.	511	511
1000 g.	511	511
		Single dissection in lower section.

### References



Patient undergoing Right Lumbar Sympathectomy

Case 27.- Male, aged 59 years.

Summary of Case

This patient was suffering from intermittent claudication caused by a right common iliac artery block. He was treated by right lumbar sympathectomy and his testicular pain sensation was tested both pre- and post-operatively by the method of Woollard and Carmichael (see Appendix) as before.

Operation Notes

At operation 7 cm. of the lumbar sympathetic chain were removed: the uppermost ganglion excised was very large, lay just below the right crus of diaphragm and was probably a fused L1 and L2 ganglion. The excised portion contained one other ganglion, probably L3 and there was duplication of the chain between the two ganglia.

Pre-operative Test

Right Testis		Left Testis
600 g.	Nil	Nil
700 g.	Pain in lower scrotum.	Nil
800 g.	-	Nil
1000 g.	-	Slight discomfort in lower scrotum.

Post-operative /

Post-operative Test

Right Testis		Left Testis
600 g.	Nil	Nil
700 g.	Pain in lower scrotum.	Nil
800 g.	- do -	Nil
1000 g.	-	Slight discomfort in lower scrotum.

Conclusion

Right lumbar sympathectomy (involving L1 and L2 ganglia certainly) made no apparent difference to right testicular sensation. In this patient therefore, L1 and L2 sympathetic ganglia did not play an important part (if any) in the path transmitting testicular afferent fibres.

Anaesthesia  
to  
L1/L2  
area

Testes  
still  
sensitive  
to gross  
stimulation

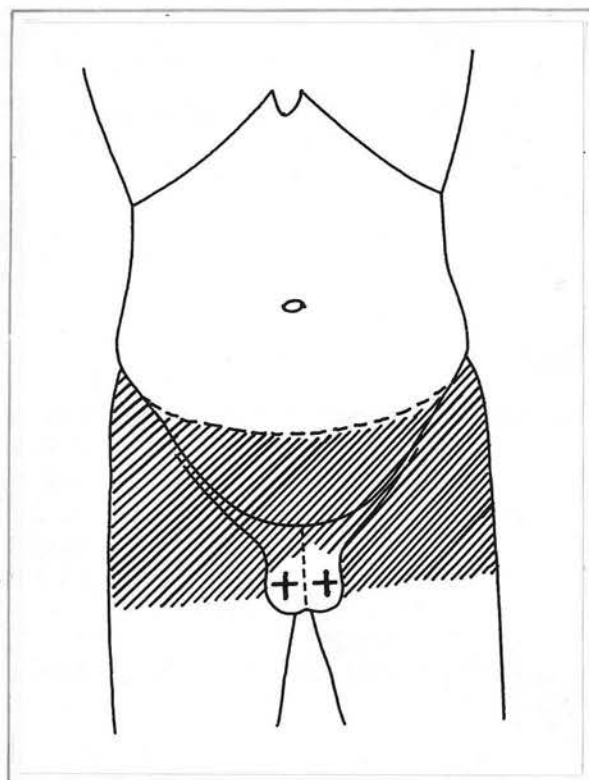


Figure 33

Anaesthesia  
to  
T11/T12  
area

Testes  
insensitive  
to  
gross  
stimulation

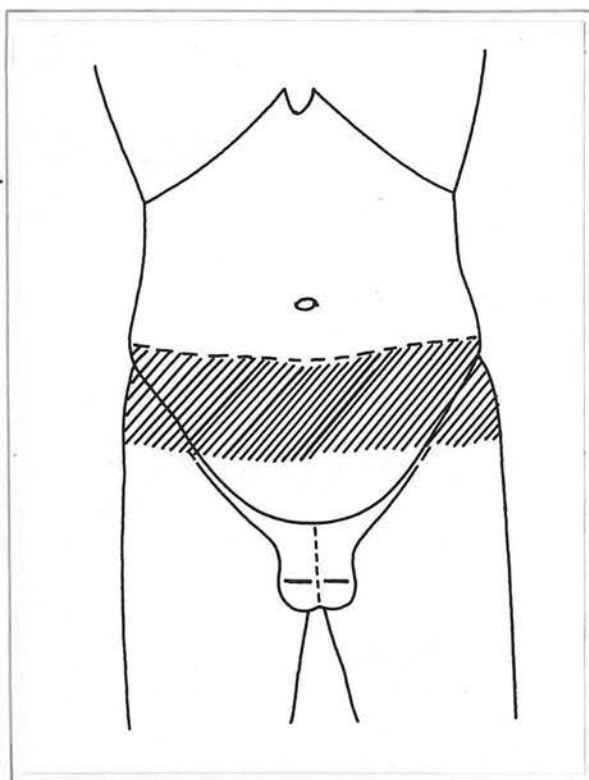


Figure 34

## Patient undergoing Extra-dural Anaesthesia

### Case 28.

#### Summary of Case

This patient was undergoing an operation under extra-dural anaesthesia. Following insertion of the epidural anaesthetic (procaine) the level of cutaneous anaesthesia to the stimulus of pin-prick was followed as it ascended with the progression of the effect of the anaesthetic; at the same time testicular sensation was noted by applying manual compression to the testes.

The tests were carried out by an independent examiner.

#### Results

When cutaneous spinal segments T11 and T12 became insensitive to pin-prick the testes also became insensitive to the stimulus of compression (Figs. 33 and 34).

#### Conclusion

In this patient testicular afferent fibres appeared to be entering the spinal cord through the spinal nerves at T11 or below that level for one or two segments.

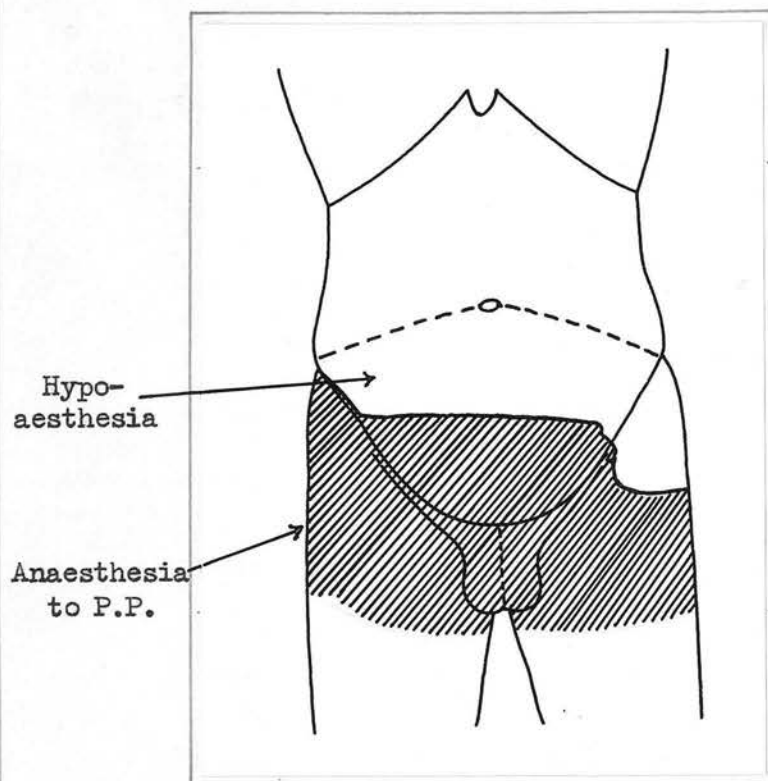


Figure 35

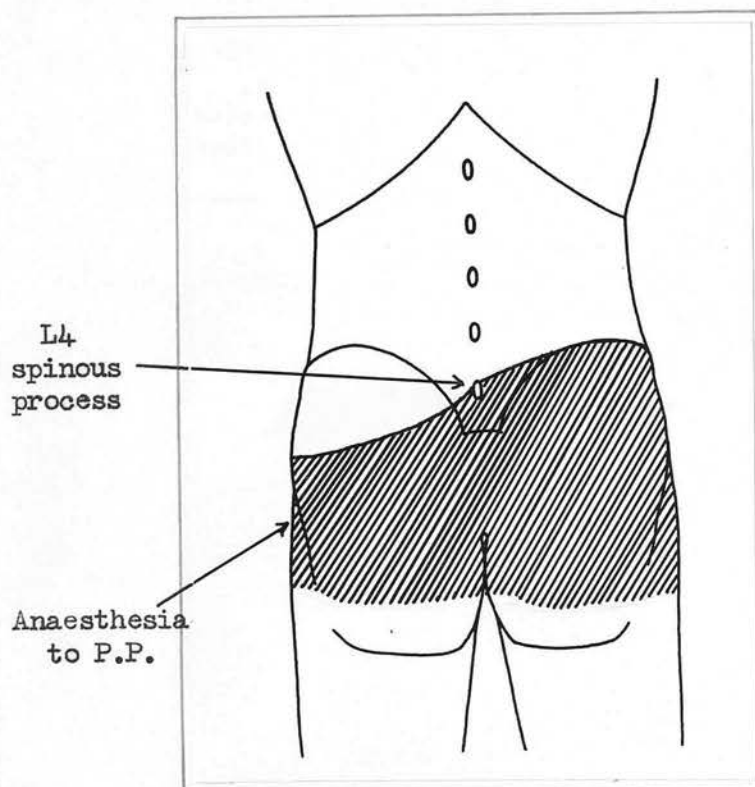


Figure 36

Spinal Cord Interruption (at T11 level)

Case 29.

Summary of Case

In 1944 this patient sustained a gun-shot wound of the spinal cord which necessitated permanent supra-pubic drainage. He had been both impotent and sterile since injury.

Sensation was assessed by the neurologist as:-

Right Side		Left Side
Light Touch	Anaesthetic T11 and below.	Anaesthetic T11 and below.
Pin-prick	Analgesic T11 and below. Hypoaesthetic T11 and below.	Analgesic L1 and below. Hypoaesthetic T11 and below.

See Figs. 35 and 36.

The patient was an intelligent and co-operative man who described his sensations well.

Results /

Results of testing testicular pain sensation:-

Right Testis	Left Testis
<p>Not sensitive to 750 g. weight.</p> <p>Squeezing testis caused pain located without hesitation at internal inguinal ring. The pain was only a "feeling".</p> <p>Rolling of epididymis between fingers elicited no response.</p>	<p>Sensitive to 750 g. weight.</p> <p>Squeezing testis caused pain at internal inguinal ring. The pain was quite severe in degree.</p> <p>Rolling of epididymis between fingers caused "a sensation" somewhere in lower left abdomen, difficult to localise.</p>

Points of Interest

(1) There was better cutaneous sensation on the left than on the right side with partial sparing of T12 and L1 on the left.

(2) There was epididymal sensation on the left, not on the right.

(3) 750 g. weight elicited a testicular response on the left, not on the right.

(4) From the findings it could be concluded that all testicular afferent impulses were entering the cord at T11 level or below, and further that the partial escape of T11 and T12 on the left side allowed only a few impulses to pass, but sufficient to show that impulses were entering the cord in that region.

Spinal Cord Interruption (at L2 level)

Case 30.

Summary of Case

In 1945 this patient sustained a gun-shot wound of the spinal cord which traversed L2 vertebra. This resulted in analgesia to pin-prick in the legs as follows:

Right leg: analgesic (pin-prick) L2 area and below.  
Left leg : analgesic (pin-prick) L3 area and below.

On testing, the scrotum proved to be fully sentient to stimuli except posteriorly where there was some blunting.

Results of testing testicular pain sensation:-

Right testis - pressure caused pain located to testis.  
Left testis - pressure caused pain located at internal inguinal ring: this result was obtained without prompting and despite the fact that the scrotum was sensitive to touch and that the tests were therefore made through a structure itself sensitive. A later test caused pain located to the testis.

Points of Interest

(1) The location of pain at the internal inguinal ring on the left side although the stimulus was applied to the testis and scrotum.

(2) The presence of normal testicular sensation in this patient despite a lesion of L2 level in his spinal cord, thus suggesting that testicular afferent fibres entered the cord above this level, i.e. at L1 level or above.



Some  
central  
sparing

Shaded  
area  
analgesic  
(to P.P.)

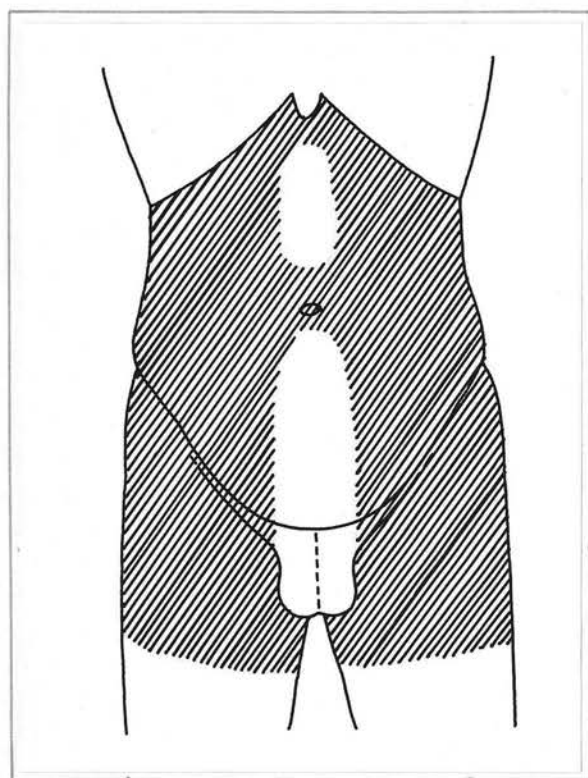


Figure 37

Spinal Cord Interruption (at T5 level)

Case 31.

Summary of Case

This patient had a fracture dislocation at T5 level resulting in anaesthesia and analgesia at T6 level and below. Since his injury, because of his urinary complications, he had suffered from acute epididymitis but this had not caused him any pain.

Repeated testing of cutaneous sensation had shown some central sparing in the midline of the abdomen including the scrotum (Fig. 37).

Results of testing testicular pain sensation:-

A stimulus of pressure did not elicit pain from either testis. In both testes there was vague sensation resulting from strong pressure but this response was identical with that resulting from strong pinching of the scrotal skin without disturbing the testes.

Points of Interest

(1) The absence of pain sensation in both testes, both to testing and to the attack of epididymitis.

(2) Testicular afferent impulses must therefore have entered the spinal cord below the level of cord segment T5.

Shaded  
area  
analgesic  
(to P.P.)

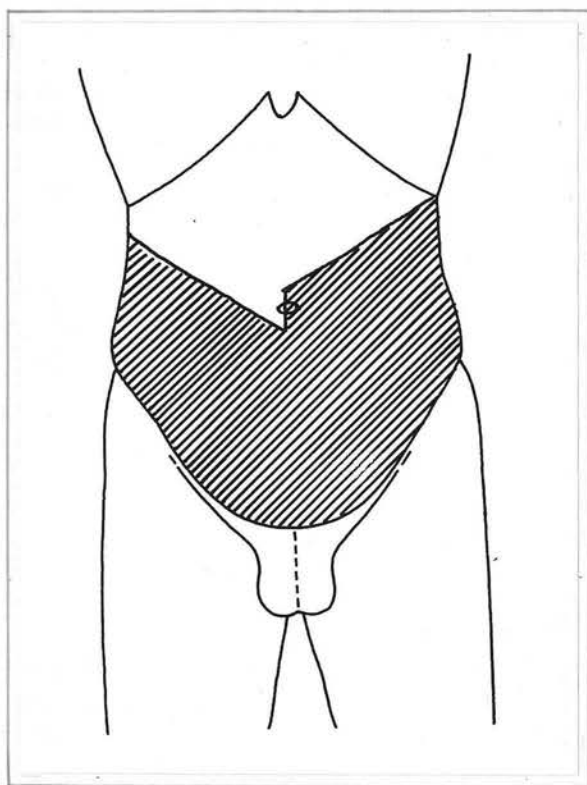


Figure 38

Spinal Cord Interruption(at T10 level)

Case 32.

Summary of Case

This patient suffered from angioblastoma affecting T10 vertebra and resulting in paraplegia, with anaesthesia T11 and below on left and T12 and below on right. Fig. 38 shows the cutaneous anaesthesia present.

Results of testing testicular pain sensation:-

	Right	Left
Firm squeezing of testis	Nil	Nil
Firm squeezing of epididymis	Nil	Nil

Point of Interest

Despite the fact that T10 dermatome was sentient on the right side, no testicular sensation was present, thus suggesting that in this patient testicular afferent fibres must have entered the cord at T11 or below.

Shaded  
area  
analgesic  
(to P.P.)

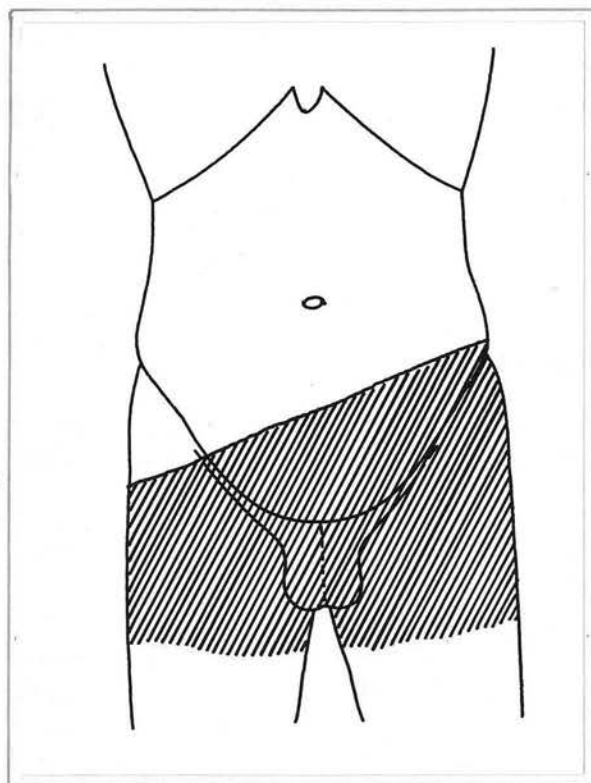


Figure 39

Shaded  
area  
analgesic  
(to P.P.)

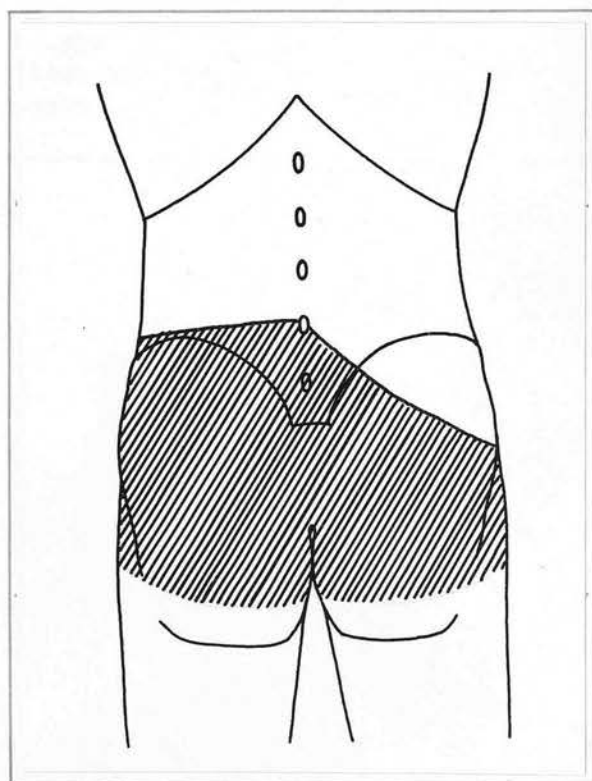


Figure 40

Spinal Cord Interruption (at T12 level)

Case 33.

Summary of Case

This patient had a Pott's paraplegia at the thoracolumbar junction with analgesia as shown in Figures 39 and 40.

Results of testing testicular pain sensation:-

Right	Left
800 g. weight gives vague pain over 10th rib in mid-axillary line at X in Fig. 39. Squeezing testis gives similar response. Squeezing epididymis gives no response.	Not sensitive to 1000 g. weight.  Squeezing testis gives no response. Squeezing epididymis gives no response.

Points of Interest

(1) T10 and T11 cutaneous segments appeared sentient on both sides yet no testicular sensation was present on the left side. However, sensation was perceived to a lower level on the right side (Figs. 39 and 40).

(2) The reference of vague pain to a point in T10 cutaneous segment on the right side suggested that a few testicular afferent fibres were entering the 10th segment.

No response to  
stimulation of  
testis

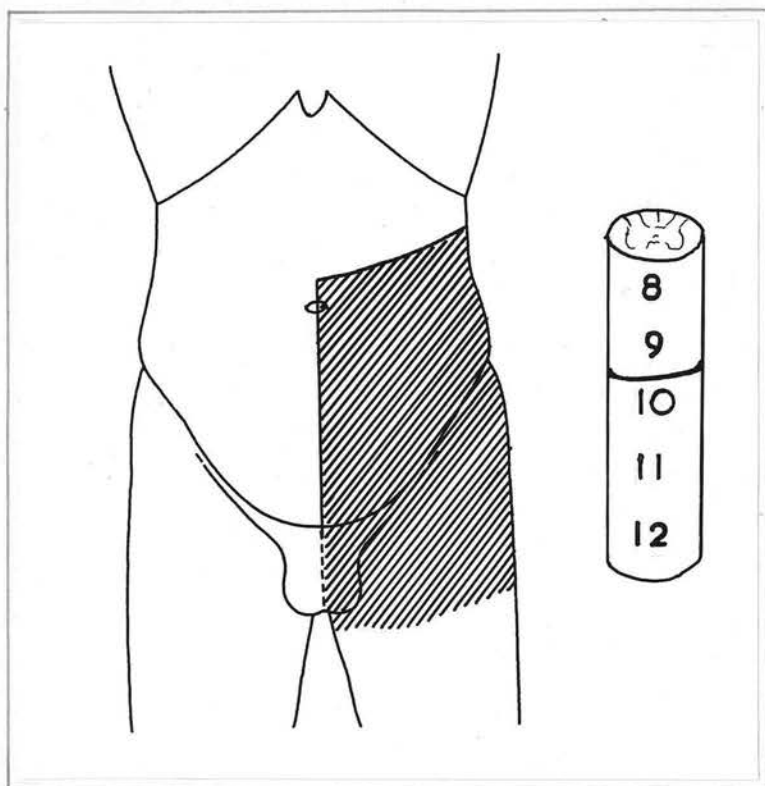


Figure 41.- 24 hours post-operative

\*  
Testicular  
stimulation  
gives discomfort  
here

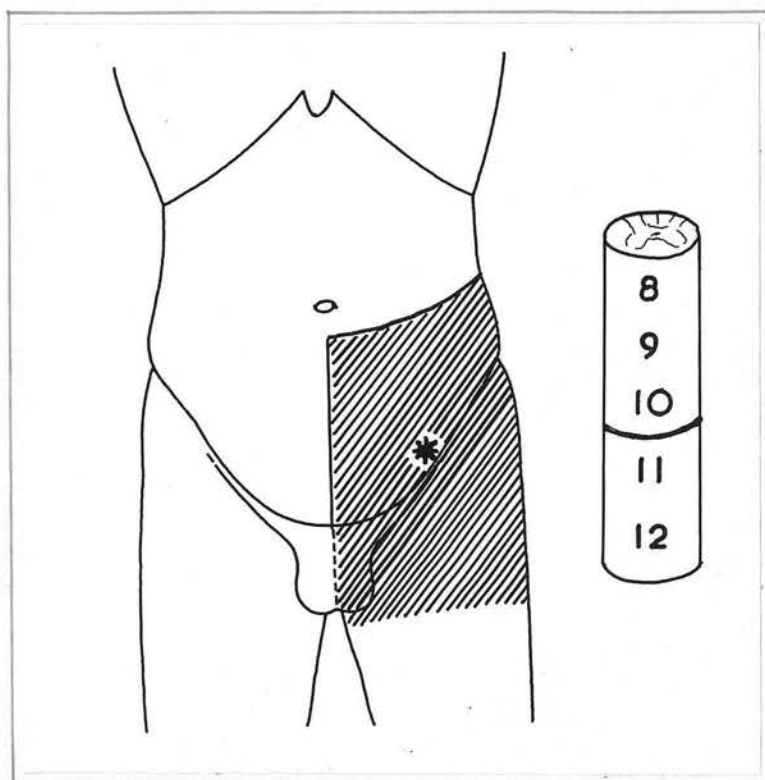


Figure 42.- 48 hours post-operative

Testicular  
stimulation  
gives response  
similar to that  
on R. side

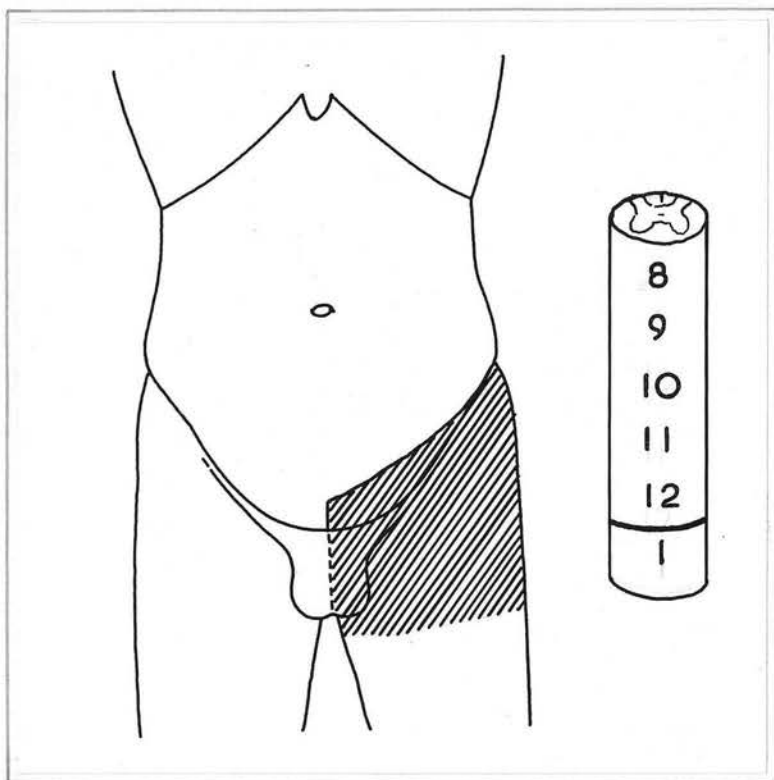


Figure 43.- 72 hours post-operative

\*  
Testicular  
stimulation  
(maximal) gives  
very vague response  
here

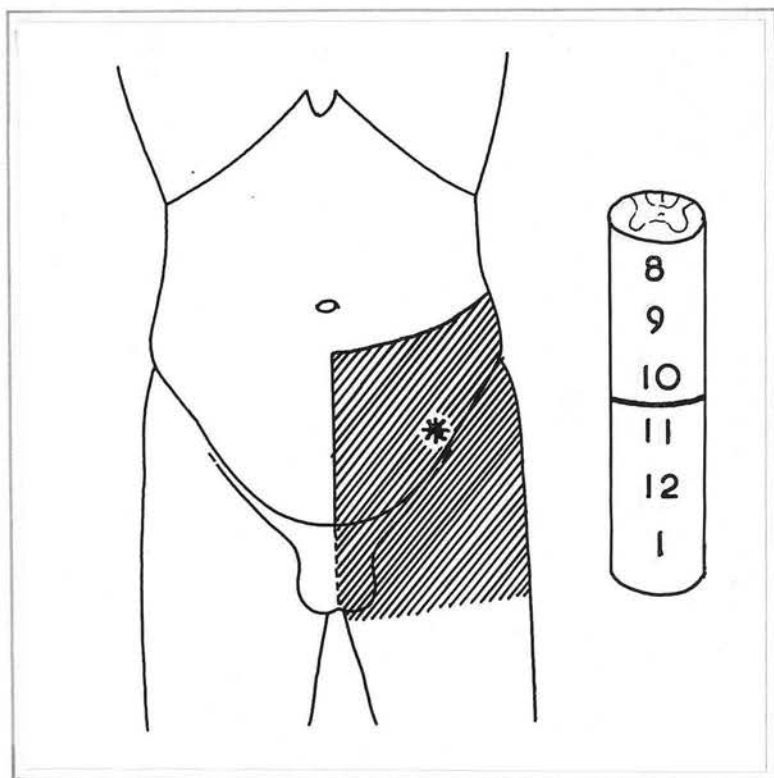


Figure 44.- 9 days post-operative



# Antero-lateral Chordotomy

## Case 34.

### Summary of Case

This patient was treated by left antero-lateral chordotomy for persistent pain in his left leg resulting from a prolapsed intervertebral disc. The following tests of sensation were carried out in the post-operative period as the level of analgesia first regressed distally and then later stabilised at a slightly more proximal level. The response on the right side remained constant as it was unaffected by the chordotomy, and the results of testing the right side are therefore given only once although testing was repeated on each occasion the left side was examined.

Results of testing testicular sensation:-  
(see also Figs. 41-44).

	Level of cutaneous analgesia (P.P.)	Response to testicular compression	Response to weight on testis
Right testis	Nil	Pain low in R.I.F.	700 g. causes pain above medial half of inguinal ligament.
Left testis 24 hrs. post-op.	T10 and below.	Nil	Nil
Left testis 48 hrs. post-op.	T11 and below.	Discomfort above symphysis pubis.	700 g. causes discomfort above pubic tubercle.
Left testis 72 hrs. post-op.	(T12) L1 and below.	Pain low in L.I.F., not so marked as on right testicular compression.	1000 g. causes discomfort low in L.I.F., not so marked as 1000 g. on right testis.
Left testis 9 days post-op.	T11 and below.	Nil. Very severe compression causes vague sensation at internal inguinal ring.	Nil

Points of Interest

(1) With T10 cord segment functioning some testicular sensation was present.

(2) With T10, 11 and 12 cord segments functioning testicular sensation was almost normal.

(3) The majority of testicular afferent fibres therefore appeared to be entering the cord in T10, 11 and 12 segments.

### III. ILLUSTRATIVE CASE OF REFERRED RENAL PAIN

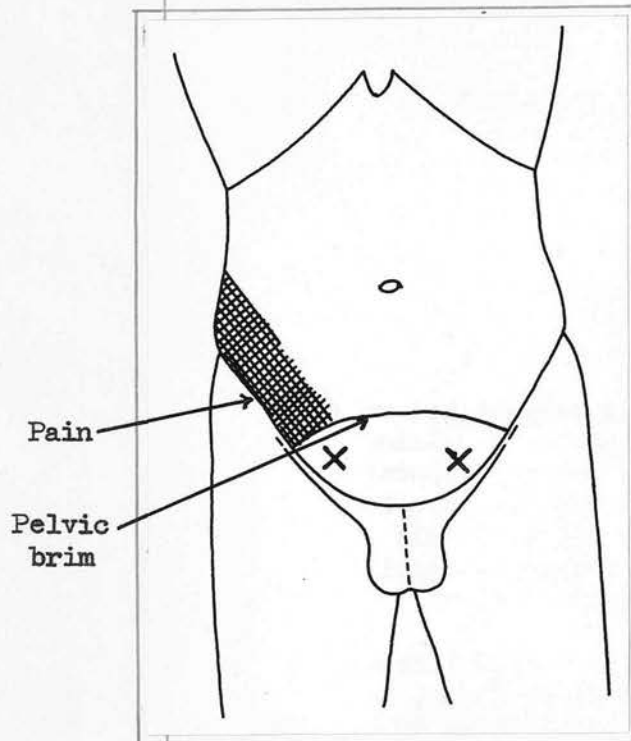


Figure 45

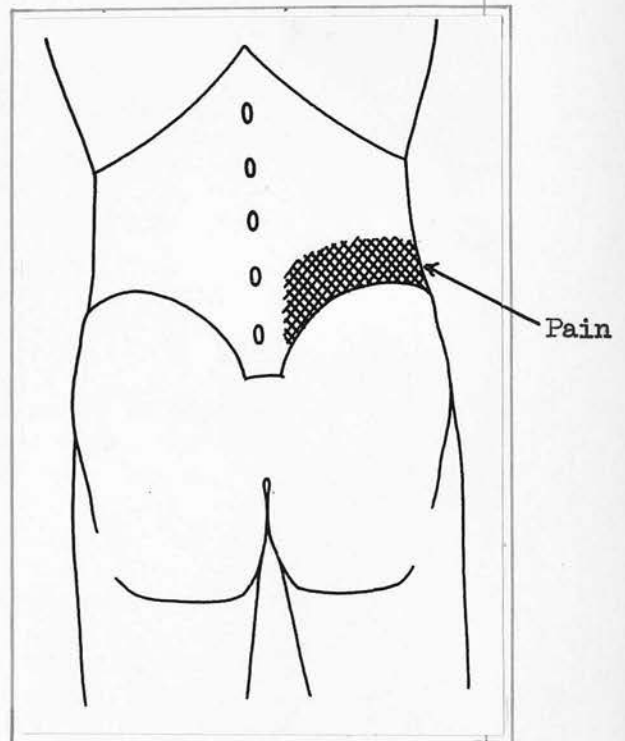


Figure 46

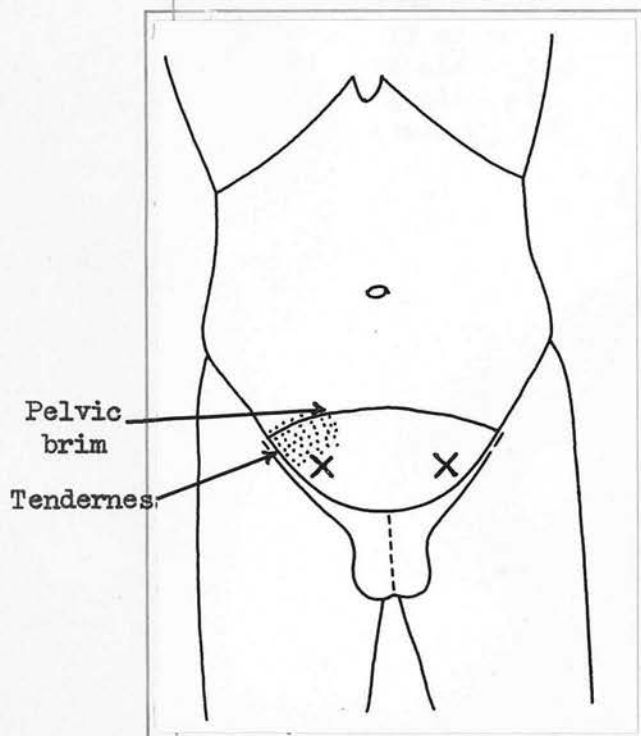


Figure 47

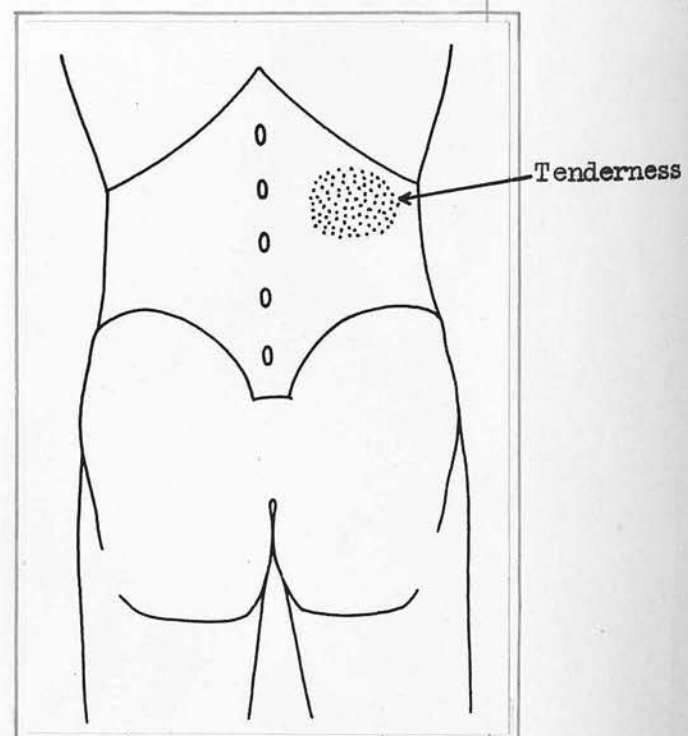


Figure 48

X = Position of kidneys

### Referred Pain from Kidney

Case 35.- Male, aged 57 years.

#### Summary of Case

At the age of 47 years this patient had undergone synchronous combined abdomino-perineal excision of the rectum for carcinoma. At that original operation he had been found to have bilateral ectopic kidneys both of which lay in the true pelvis at upper sacral level; since that operation he had suffered from urinary incontinence and on that account wore a penile clamp.

At the age of 57 years he developed increasingly severe aching pain in the right iliac fossa, the pain radiating upwards to his flank and through to his back (Figs. 45 and 46). He was pyrexial, suffered rigors and vomited.

Examination at this time showed tenderness in the right iliac fossa and very definite tenderness in the right renal angle (Figs. 47 and 48). A diagnosis of right pyelo-nephritis was made and urine culture grew Ps. pyocyanea. Treatment with intravenous fluids and oral Furadantin was given with relief of his symptoms. Intravenous pyelography confirmed the pelvic position of his kidneys, both renal pelves and both ureters being considerably dilated.

#### Point of Interest

Despite the ectopic position of the right kidney (in the true pelvis), this patient suffered from pain in the right iliac fossa, the right loin and back, and he exhibited tenderness in the right renal angle - i.e. in the site where his kidney should normally lie.

Fig. 2. Patients suffering from hydrocoele of the  
 tunica vaginalis testis were used for the following  
 experiments to investigate the sensitivity of the tunica  
 vaginalis testis itself and to investigate the site at  
 which testicular pain was felt after being induced by  
 raising the pressure inside the testicular capsule by  
 means of an injection into the body of the testis.

All these patients were in fact attending hospital  
 for treatment of their hydrocoele and the nature of the  
 tests was explained to them and their permission and co-  
 operation were obtained. Very local anesthesia in

#### IV. INVESTIGATION OF TESTICULAR SENSATION

##### IN PATIENTS SUFFERING FROM HYDROCOELE

Each experiment is described more individually and  
 the experiments are listed in the light of the findings  
 of the previous experiments. In the earlier experiments  
 to assess the ability of the tunica vaginalis testis to  
 feel pain (or rather referred pain) a patient was asked to  
 indicate the site of pain or pressure in the testis  
 and to indicate the site of pain or pressure in the  
 scrotum. The site of pain or pressure in the scrotum was  
 to be a response to touch and not to pain and accordingly  
 the patients were asked to indicate their answers with  
 one hand as to touch and the other hand as to pain. The  
 results are given in the following table.

Note.- Patients suffering from hydrocoele of the tunica vaginalis testis were used for the following experiments to investigate the sensitivity of the tunica vaginalis testis itself and to investigate the site at which testicular pain was felt after being induced by raising the pressure inside the testicular capsule by means of an injection into the body of the testis.

All these patients were in fact attending hospital for treatment of their hydrocoeles and the nature of the tests was explained to them and their permission and co-operation were obtained. Where local anaesthetic is mentioned in the experiments this always refers to 2% Xylocaine (Duncan, Flockhart & Co. Ltd.).

Each experiment is commented upon individually and the experiments are modified in the light of the findings of the previous experiments. In the earlier experiments to determine the ability of the tunica vaginalis testis to initiate a painful sensation (whether referred or otherwise) in response to pin-prick or scratch the patient was asked to answer with a "yes"; this was later realised to be a response to touch and not to pain and accordingly the patients were asked to elaborate their answers with consequent clarification of the true position as will be seen from the commentaries.



Case 36.

Notes

Large right hydrocoele. The needle entered the hydrocoele sac without any anaesthesia and the tunica vaginalis (visceral and parietal) was stimulated by scratching from within the sac. Both visceral and parietal tunica appeared to be sensitive to scratch in that a positive response was given by the patient ( i.e. the answer "yes" ) although pain did not appear to be occasioned.

A local anaesthetic block of the posterior scrotal nerves was then induced on the right side (10 ml. solution): this anaesthetised only the posterior half of the right side of the scrotum to the cutaneous stimulus of pin-prick.

Parietal tunica was then tested and found to be anaesthetic in its posterior part, roughly corresponding to the cutaneous anaesthesia.

Visceral tunica was then tested with needle scratch which caused pain located in the right testis.

The testis was then stimulated by rapid injection of 2 ml. anaesthetic solution and this caused pain located in the right testis.

Comments

From the results obtained in this experiment it appeared that both layers of the tunica vaginalis testis were sensitive. However alternative explanations must be considered.

First, only the posterior half of the right side of the scrotum was anaesthetised: the stimulation by scratch and injection (made from the front of the scrotum) was therefore carried out through structures themselves sensitive or at least partly so.

Secondly, the finding that sensitivity of the posterior parietal tunica became insensitive over an area corresponding approximately to the cutaneous anaesthesia could be held to suggest that the tunica vaginalis testis was /



was supplied by the overlying cutaneous nerves as a secondary innervation acquired after migration. A similar explanation could be offered to explain the localisation of the testicular response to the testis but this line of argument becomes unconvincing, although Cushing (1900) had noted that the "inferior pole vascular supply" was not blocked with local anaesthetic to the ilio-inguinal nerve and spermatic cord, and might constitute a sacral nerve supply to the testis. On the other hand, all the responses could be explained on the basis of stimulation of overlying sensitive skin: the testicular response could be localised by the needle passing through sentient scrotum, and the tunica "response" by stimulation of overlying skin from its inner aspect rather than from its more customary outer aspect. The abolition of response from the posterior tunica by anaesthesia of the overlying skin then becomes readily understandable.

Case 37.

Notes

Right hydrocoele. A skin wheal was raised with local anaesthetic and a cannula was then inserted into the hydrocoele without pain. The tunica vaginalis testis was then scratched with a needle passed through the cannula and a positive response obtained. At the time of the experiment it was presumed (in the light of Brown's experiments) that this response represented pain; the patient was only asked to indicate the perception of the stimulus with the answer "yes" and was not actually asked the nature of the sensation. Later it was realised that the perception was that of touch and not of pain.

200 ml. of hydrocoele fluid were then aspirated and 10 ml. of local anaesthetic solution instilled and given time to act. The tunica was then found to be largely insensitive to the same stimulus of scratch, but not entirely so.

1 ml. of normal saline was then rapidly injected into the testis but no response was obtained.

Comments

This experiment (except for the very much smaller testicular stimulus) was carried out in the way Brown (1949) conducted his tests. From the results obtained it appears that afferent impulses reach the brain as a result of scratch stimulus of the tunica vaginalis testis and that these impulses are greatly reduced by the instillation of local anaesthetic into the tunica.

Brown interpreted such results by concluding that the tunica vaginalis was itself a sensitive structure (supplied by the genito-femoral nerve) but the findings could be explained in the same way as in Case 36, i.e. the response obtained by scratching the tunica with a needle is the response of the overlying skin disturbed by the needle from its deep aspect.

Case 38.

Notes

Right hydrocoele. The parietal tunica was found to be sensitive to scratch, i.e. a positive response ("yes") was obtained as in Cases 36 and 37. The visceral tunica was found to be insensitive.

A right posterior scrotal nerve block of 12 ml. local anaesthetic anaesthetised the right scrotum and a triangle of skin on the under surface of the penis on its proximal shaft. The uppermost anterior part of the skin of the right scrotum alone remained sensitive.

On testing, the tunica vaginalis was now found to be anaesthetic to needle scratch only where the overlying scrotal skin was similarly analgesic (pin-prick) - and therefore not in the upper anterior part of tunica nor corresponding area of scrotal skin.

200 ml. fluid were then withdrawn from the hydrocoele. 6 ml. normal saline were then injected into the body of the testis. After 3 ml. the patient complained of pain in the upper outer aspect of the right thigh below the anterior superior iliac spine, and after 6 ml. he definitely referred his pain to the right iliac fossa at the internal inguinal ring. This pain was aggravated by pressure on the testis until it became unbearable, but at no time was there any reference to the scrotum or to the back.

Comments

The stimulus applied to the testis now appears to have been adequate and the pain reference was definitely in the region of the internal inguinal ring. From the results obtained it again appears that afferent impulses reach the brain as a result of scratch stimulus of the tunica vaginalis (parietal layer only) and that these impulses are abolished by the anaesthetisation of the overlying scrotum (posterior scrotal block). This finding would refute any suggestion that the genito-femoral nerve is in any way concerned with the tunica because it was not involved in the local anaesthetic block.

There /

There remain the possibilities therefore that:-

(1) Either the tunica vaginalis is not sensitive to stimulus by scratch but that any response obtained by such a stimulus is in fact the result of stimulation of the overlying skin.

(2) Or the tunica vaginalis is (in its parietal portion at least) sensitive to scratch and is supplied by the same various nerves which supply the skin overlying it. This explanation would require the further postulation that such nerves, having reached a superficial tissue plane peripherally, penetrate once again deeply through superficial fascia, and through two layers of spermatic fascia to reach their termination at the tunica vaginalis. No other example of such a course is known in the body.

Case 39.

Notes

This patient presented with swelling in the left scrotum and a complaint of "pain in the left groin". The case was misdiagnosed as hydrocoele but tapping showed it to be a spermatocoele.

Local anaesthetic was inserted to raise a skin wheal and a needle was inserted into the sac through the wheal and a scratch stimulus applied to the wall of the spermatocoele. In the light of previous experiments the patient was asked not only to record his response with a "yes" but to describe his sensations. The stimulus resulted in no pain whatever but a positive response ("yes") was obtained as the patient noticed the "ping" as the cyst wall sprang away from the needle point on being released at the end of the scratch - he said he felt the stimulus as a "tap".

A posterior scrotal block with 12 ml. local anaesthetic was then induced on the left side and gave complete analgesia and anaesthesia of the entire left half of the scrotum and on the underside of the left half of the penis - the line of demarcation was exact. 150 ml. of spermatocoele fluid were then withdrawn.

The testis was then stimulated by injecting normal saline into it; when 2 ml. had been injected the patient complained of pain low in the left iliac fossa.

Comments

Because the lesion proved to be a spermatocoele and the scratching needle was therefore applied to the spermatocoele, no direct deduction as to the tunica vaginalis is relevant. Nevertheless, the similarity of the response to stimulating the spermatocoele to the response to stimulating the tunica is striking. This would imply that either the spermatocoele is endowed with similar afferents to the tunica (although of totally different development) or that in both instances the response is being obtained from the displacement of overlying skin.

The reference of testicular pain to the iliac fossa just above the inguinal ligament is confirmed as before, absence of local signature being ensured by the posterior scrotal block.

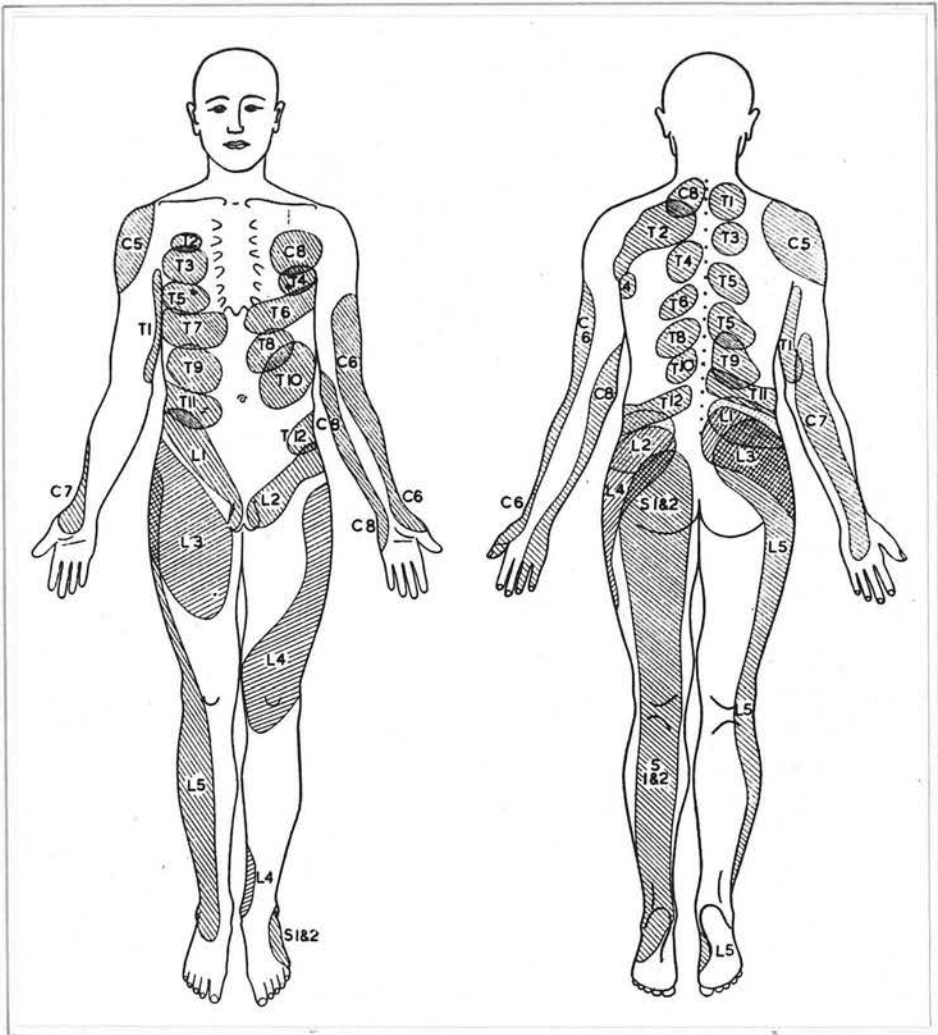


Figure 49



Case 40.

Notes

This patient was suffering from a right hydrocoele causing pain at the medial end of the inguinal ligament and over the region of the pubic tubercle; this pain radiated upwards and backwards to pass below the anterior superior iliac spine, below the crest of the ilium. The distribution corresponded with L2 cutaneous area in Fig. 49 (Lewis, 1942).

A skin wheal was raised with local anaesthesia and a needle passed into the hydrocoele and the tunica vaginalis tested for sensitivity to pin-prick and to scratch. Throughout this procedure the patient felt no pain but felt the "tap" as tunica sprang away from the needle as in Case 39.

Comments

In this patient the tunica vaginalis testis appeared to be quite insensitive to the stimuli applied (pin-prick and scratch) and any response obtained appeared consistent with displacement of the overlying skin.

Case 41.

Notes

This was an elderly patient suffering from a very large left hydrocoele. A skin wheal was raised with local anaesthetic, a needle thus painlessly inserted into the hydrocoele and the tunica tested to the stimuli of pin-prick and scratch: no pain was evoked by such stimuli unless the exploring needle was thrust so far into and through the tunica as probably to prick cutaneous nerves to the overlying skin from their deep aspect.

A posterior scrotal block was then inserted using 15 ml. local anaesthetic and resulted in anaesthesia of the left half of scrotum. 710 ml. of hydrocoele fluid were then aspirated and the tunica vaginalis testis again tested as before. Once again both parietal and visceral layers seemed insensitive to these stimuli as pain was not experienced.

A needle was now passed into the testis and 5 ml. normal saline injected into the body of the testis until it felt hard with the distension: this resulted in pain referred to the left iliac fossa which was made intense by any added pressure on the testis from the supporting hand.

Comments

In this patient the reference of pain induced in the testis to the iliac fossa was confirmed. Once again the tunica vaginalis testis does not appear sensitive to pain from the stimuli applied.



Case 42.

Notes

This patient was suffering from a large right hydrocoele and the following clinical experiment was conducted by an independent observer.

A skin wheal was raised with local anaesthetic and a needle passed into the hydrocoele sac and its sensitivity to the stimulus of scratch determined. The following results were obtained:

- (a) Parietal layer of tunica: not painful on stimulation.
- (b) Visceral layer of tunica: not painful on stimulation.

Comment

These tests were carried out by an impartial observer and confirmed that the tunica does not seem sensitive to scratch.

Case 43.

Notes

This patient was suffering from a left hydrocoele and the following clinical experiment was carried out by an independent examiner.

A skin wheal was raised with local anaesthetic and a needle then passed into the hydrocoele sac without pain. The tunica vaginalis testis was then stimulated by needle scratch and the following results were obtained:

- (a) The parietal layer of tunica vaginalis testis was not sensitive to scratch.
- (b) Visceral layer of tunica vaginalis testis - on applying a stimulus of scratch the patient experienced pain referred to the abdomen just above the inguinal ligament (but no pain in the scrotum).

Comments

These tests were carried out by an impartial observer and would suggest that the parietal layer of tunica vaginalis is not sensitive to the stimuli applied. The test would however suggest that the visceral layer is indeed sensitive but that the resultant pain is referred to an area low in the abdomen; this finding could be explained by the stimulation of testicular afferent fibres since the area of reference coincides with that previously shown to result from testicular stimulation.

Case 44.

Notes

The following experiment was again conducted by an impartial observer on a patient suffering from hydrocoele.

A skin wheal was raised with local anaesthetic and a needle then painlessly introduced into the hydrocoele sac. Both visceral and parietal layers of tunica vaginalis testis were tested by scratching and neither was found to be sensitive.

Comments

Again the tunica vaginalis testis does NOT appear to be sensitive to scratch, the experiment having been conducted by an impartial observer.

Case 45.

Notes

This patient was suffering from a left hydrocoele. The scrotum was first carefully tested for sensation to pin-prick and both sides were found equal. A skin wheal was then raised with local anaesthetic, a large bore needle inserted into the hydrocoele sac, and 750 ml. fluid aspirated.

20 ml. of 2% procaine were then instilled into the hydrocoele sac and left in situ for five minutes; after this time the sac was emptied of 100 ml. of fluid containing the procaine. The scrotum was then re-tested for sensation to pin-prick and slight but definite hypo-algesia (to pin-prick) found on the left side of scrotum as compared with the right side.

Comments

Despite the dilution of the anaesthetic agent, its presence inside the tunica vaginalis testis undoubtedly appeared to diminish the sensation of the overlying skin. This could be explained only by diffusion of the drug out of the sac and into the cutaneous nerves.

Case 46.

Notes

This patient was suffering from a right hydrocoele. The scrotum was first carefully tested for sensation to pin-prick and both sides were found equal. A skin wheal was then raised with local anaesthetic and a cannula inserted without pain into the hydrocoele sac. 1000 ml. fluid were then aspirated from the sac and the tunica vaginalis tested with the stimulus of scratch through the cannula: no pain was thereby produced and the patient felt the stimulus only when it displaced overlying skin - he "felt the tap" as in previous experiments (Cases 39 and 40).

10 ml. of local anaesthetic were then injected into the hydrocoele sac, left for five minutes and then the sac aspirated completely - 100 ml. fluid being withdrawn: it was thus obvious that the anaesthetic had been greatly diluted and accordingly 12 ml. local anaesthetic (mixed with 4 ml. quinine-urethane) were injected into the sac and the cannula was withdrawn.

The patient was then re-tested after five minutes and again after sixty minutes for sensitivity of the two halves of scrotum to pin-prick. These tests left no doubt that the skin of the right half was hypo-algesic to pin-prick as compared with the skin of the left half.

Comments

This experiment once again supported the previous observations that the tunica vaginalis testis is not itself sensitive to scratching and pin-prick. The diminished sensation over one half of the scrotum after local anaesthetic had been instilled into a hydrocoele on that side shows again that the overlying cutaneous nerves had been partially blocked by diffusion of the anaesthetic agent outside the sac.

## DISCUSSION

### The Site of Pain Caused by Disease of the Testis

The published results of torsion of the spermatic cord or of the testis show that in a large proportion of cases the testis is destroyed by the vascular insufficiency which occurs. Robb (1956) lists 30 cases of whom "only 3 patients were left with a testis of normal size and consistence" and Adams and Slade (1958) state that surgery saves only 50%; however, some of these testes "saved" by surgery will subsequently undergo atrophy. Since many of the patients suffering from torsion of the testis appear to have an underlying developmental defect (concerned either with the descent of the testis, or with the investment by the tunica and a mobile epididymis) and that defect bilateral, then eunuchism is a likely possibility. It would seem difficult to rationalise such end-results with the superficial and easily accessible position of the testis. Similarly, in view of its position, the diagnostic delay between the onset of symptoms and admission to hospital is difficult to understand: in the series quoted by Robb (1956) the average delay was 5.5 days so that it is not surprising that at operation so many testes are found to be gangrenous. The necessity for earlier diagnosis and treatment has been emphasised by Burkitt /

Burkitt (1956) and Chambers (1956), and the reasons for diagnostic delay merit more detailed consideration.

It is currently taught that the presenting symptom of patients with torsion of the testis and of the hydatid of Morgagni is "pain in the testis". Thus Campbell (1951) writes of "pain in the scrotum, testicle and groin"; Aird (1949) writes "there is sudden pain in the testis" and Baillie and Love (1948) refer to "sudden and agonizing pain in the organ". In the present series, of the six patients suffering from torsion of the testis (Cases 1 - 6), and the seven patients suffering from torsion of the hydatid of Morgagni (Cases 7 - 13), it is evident that in each and every one the initial pain was in the groin or abdomen and not in the testis. This abdominal and/or groin site for pain originating in the testis is confirmed by the pain experienced by patients suffering from widely differing pathological conditions of the testis (Cases 14 - 24). Similarly, Baty (1956) records six cases of cremasteric cramp in five of whom the pain was recorded in the groin; Blandy (1957) reports three patients with torsion of the testis, one of whom had abdominal pain as his earliest symptom, and another had undergone appendicectomy (presumably having had abdominal pain) during an earlier attack. Therefore it would appear that so long as students are taught to expect pain in the testis in /



in such circumstances, there will be inevitable diagnostic delay and error.

The apparent logic of expecting to find pain located accurately to the site of the stimulus is so pressing that this also enhances current teaching. Not infrequently the clinical facts will be unintentionally misrepresented: in Case 9 of the present series, the site of pain, although initially described as in the groin, was subsequently noted in the case summary to be in the scrotum. Some patients themselves recognised that "the pain is not where it should be".

From the present series of cases there would seem little doubt that pain arising from testicular disease (where the process is confined to the testis) is referred to the lower abdomen and groin of the same side: indeed the most constant point of reference is to the region of the deep inguinal ring as Brown (1949) suggested. The evidence in favour of pain being referred to such a site is further strengthened by the abdominal reference site for pain in a patient whose testes were ectopic (Case 22), or even undescended (Case 23): in this respect there is a striking similarity between the occurrence of pain at its original site both in ectopic testis and ectopic kidney (Case 35), such cases supporting Brown's (1942) theory that the pain is referred to the primitive embryological site of the viscus regardless of its subsequent change of position /



position. Poulton (1949) recorded a similar case wherein a diagnosis of right pyelitis was made on the grounds of right-sided pain and tenderness together with urinary symptoms; subsequent investigation revealed a condition of crossed ectopia, both kidneys lying on the left side of the abdomen.

Case 24 of the present series provides an almost perfect clinical example of infarction of the testis as a result of the injection of radio-opaque medium for aortography: this patient's pain was located low in the right iliac fossa in the region of the deep inguinal ring (Fig. 29), and the diagnosis was not made by the attending physician until this pain had been present for five hours, by which time tenderness in the scrotum had become apparent to the patient.

The location of testicular pain in the lower abdomen or groin is further confirmed by the evidence derived from the experiments on patients with hydrocoele (Cases 36 - 46).

#### The Nature of the Pain Arising in the Testis

The nature of the pain suffered by patients with lesions of the testis is of interest quite apart from its situation: it is described as being vague in site, deep in position, sickening in character - a description typical of visceral pain. The very nature of this pain leads to diagnostic /

diagnostic error: in the present series of cases there were numerous examples of misdiagnoses incriminating such causes as constipation, stomach upset, appendicitis and "chronic abdominal pain". One patient, noting the similarity to the discomfort occasioned by constipation, attempted to relieve his pain by defaecation. Many patients are apparently content to accept that abdominal pain is probably not of serious import and that they must await further symptoms before consulting their doctor, and are thus often the cause of delay.

#### Testicular Tenderness and Local Pain

On examination, many of the patients whose case histories are recorded above showed tenderness in the lower abdomen on the affected side. This site for tenderness can be explained in the same way as the site for pain is explained and will be discussed again later.

Some case histories showed a record of pain in the scrotum however and it is necessary to consider this further. The distinction between spontaneous pain in the scrotum and local scrotal tenderness is that the latter is a response to a stimulus seeking to elicit discomfort. In a structure placed as the testis is, in an exposed and vulnerable position, it would appear to be difficult to dissociate spontaneous local pain from tenderness caused by the slightest movement of the part by the adjacent thighs. A patient /

patient with disease of the testis in its early stages will experience lower abdominal pain. Movement of the thighs or pressure from the patient's hand or doctor's examining hand on the scrotum may then further raise the pressure within the testicular capsule so that worsening of the pain (or onset of the pain if it was previously subliminal) occurs; however this now has the local signature of the scrotum and the pain may be "localised" there by the patient. It is, however, preferable to consider this as tenderness. In many of the patients in the present series the feature which eventually directed attention to the testis was in fact local scrotal tenderness and not local pain (e.g. Cases 3, 13, 15, 20 and 24). Several patients described their scrotal tenderness as "pain when I move". In such patients the pathological process may eventually spread to the overlying scrotum to produce redness, oedema, heat and local pain: nevertheless this pain, as distinct from tenderness, is a late feature.

On the other hand, scrotal pain may occur as an early feature if the scrotum is involved at an early stage by the disease process, e.g. by trauma, and this is well illustrated in Case 19.

#### Sensitivity of Tunica Vaginalis Testis

The results of the experiments on patients suffering from hydrocoele of the tunica vaginalis testis (Cases 36 - 46) suggest that the tunica is not sensitive to the stimulus /

stimulus of pin-prick or scratch. It is very easy during such experiments to disturb the overlying skin of the scrotum and even to stimulate the afferent receptors in the overlying skin, thus producing an apparently positive response from the tunica. Thus Explanation (B) (see p. 19) of the experimental findings of Brown and of Woollard and Carmichael would seem to be supported by the present experiments, that is, that the apparent sensitivity of the tunica vaginalis testis is derived from stimulation of the overlying tissues and is not due to any sensory property of the tunica. The insensitivity of the tunica was confirmed by three impartial observers (Cases 42 - 44) and supported by the similarity of response obtained in the experiment on the patient with a spermatocoele (Case 39): in this case the similarity of the response suggests either that the spermatocoele is endowed with similar afferents to the tunica (although of totally different development), or that in both instances (spermatocoele and hydrocoele) the response is obtained from displacement of the overlying skin.

The effect of local nerve block (of the posterior scrotal nerves) in abolishing cutaneous sensation over that portion of the hydrocoele sac which subsequently gave no response even to stimulation gross enough to disturb the overlying skin, and the effect of local anaesthetic instilled directly into the hydrocoele sac in producing analgesia of the overlying skin (Case 45), similarly support /

support the theory that the tunica vaginalis testis is itself not sensitive to such a stimulus as scratch, but that a response may be obtained inadvertently from overlying tissues. Whether this theory is accepted or not, the experiments would seem to show that the genito-femoral nerve does not play any part in the afferent supply of the tunica vaginalis testis, since the only other interpretation of the experimental findings (Explanation (A), p. 19) also does not invoke the participation of this nerve.

#### Sensitivity of Peritoneum

Any theory suggesting that the tunica vaginalis testis is not itself sensitive must imply either that this small peritoneal sac differs from the general peritoneum (although developed from it), or, alternatively, that Capps' theory of peritoneal sensation is unsound. Mackenzie (1920) claimed that peritoneum is not sensitive to cutting, scratching or stitching, whereas Capps (1932) found from clinical experiment that light contact of a rough point on the parietal peritoneum produced accurately localised pain. Brown (1949) also described the tunica vaginalis testis as endowed with pain afferents capable of accurately localising the stimulus of scratch, but the evidence derived from the present series of cases is not in keeping with this view. Since it would seem reasonable to postulate that the tunica vaginalis testis would be endowed with /



with nervous connections and afferent receptors in a similar fashion to the general peritoneum, Capps' experiments warrant more detailed scrutiny.

The experiments of Capps (1932) which are quoted in the majority of medical text-books were conducted as follows:-

The skin of the abdomen or chest was anaesthetised by a spray of ethyl chloride and a cannula then passed through the parietes in the analgesic area. Through the cannula a silver wire was then passed and the neighbouring peritoneum or pleura tested to the stimuli of pressure and scratch.

As a result of these experiments, Capps concluded that the parietal pleura and the parietal peritoneum are capable of accurately localising such stimuli: however, he recorded the visceral pleura as insensitive, but in his conclusions did not mention the visceral peritoneum. Since the sentient areas are those areas of the parietes where stimulation of overlying tissues might occur it seems strange to postulate that the visceral pleura is endowed by nature in a different manner to the parietal pleura when, in fact, this difference is one of descriptive anatomy only. In his discussion Capps admits that Mackenzie would attribute the pain reception and localisation to penetration into the sensitive subserosa, but he refutes this argument by the statement that "it is easier, however, to assume that both /

both structures are sensitive since both have the same supply of cerebrospinal nerves". He does not, however, produce evidence to support this statement. His method of ascertaining the localisation of the stimulus is of interest:-

"parietal pleura can be reached at one or more points distant from the cannula, where the wire point becomes visible, pressing out an interspace.

"the silver wire was passed with ease along the inner abdominal wall in the direction of the arrows [shown in his diagram], the point being readily detected by the palpating finger and even with the eye" (Capps, 1932).

It could be argued, therefore, that all Capps' conclusions could be explained by the stimulation of overlying tissues and overlying nerves and that his experiments in no way prove that the peritoneum or pleura is endowed with accurately localised pain receptors.

Theories affirming the sensitivity of the peritoneum are often supported by quoting the extreme pain of a perforated duodenal ulcer, but the clinical difficulty which occasionally arises in differentiating an acute exacerbation of a duodenal ulcer from a frank perforation should be borne in mind. If the peritoneum (certainly the parietal peritoneum) is so accurately sensitive as Capps suggested, why should there be any difficulty in such a differential diagnosis when in one case the peritoneum is bathed by irritant duodenal contents, and in the other case, not? The pain of a perforated duodenal ulcer could well be /

be explained as visceral pain of maximal severity, "projected" to segments across the upper abdomen, and differing only in degree and not in mechanism from that of an acute (but not perforated) duodenal ulcer. Similarly, the localised (secondary) pain of appendicitis, on which Morley based his support for the sensitivity of the peritoneum, could be explained as the effect of local muscular tone and movement in the right iliac fossa raising tissue pressure in the inflamed appendix and so increasing visceral pain - but this "spontaneous tenderness" would have the local signature of the right iliac fossa as described by Kinsella (1948).

Whether the view (originally put forward by Mackenzie) that the peritoneum is not itself sensitive to painful stimuli is accepted or not in no way detracts from the fact that the conclusions of Capps, which are all too often recorded and taught as "facts", are based upon experiments of doubtful validity.

#### The Pathway of Pain Impulses Arising in the Testis

Because the site of pain arising in the testis which is ectopic (e.g. Case 22), and in the testis which has been placed in the scrotum by operation (e.g. Case 23), is similar to that arising in the normally descended testis, it can be argued that its afferent pathway accompanies its vascular supply and that secondary innervation does not occur.

The /



The sympathetic plexus (including "sympathetic afferents") surrounding the testicular vessels has been demonstrated and dissected by both Hovelacque (1927) and Mitchell (1953) and according to these authors the testicular afferents are transmitted through the renal and inter-mesenteric plexuses to reach the spinal cord. These afferents may pass through, but do not relay in, sympathetic ganglia. In the present series, Cases 26 and 27, undergoing right nephrectomy and right lumbar sympathectomy respectively, experienced no discernible alteration in testicular sensation as a result of operation: this implies that, in these patients, no appreciable number of testicular afferent fibres passed through the renal plexus or through L1 and L2 sympathetic ganglia.

The spinal segment at which the testicular afferent fibres enter the spinal cord is of interest because reference of pain will occur in corresponding cutaneous areas. The segments suggested by various authorities are summarised in the following table:-

Author	Spinal Cord Segment
Kuntz (1929)	T10
Morley (1931)	L1 L2
Jamieson (1942)	T10
Martin (1943)	T10
White (1943)	T10
Pottenger (1944)	T10 T11 T12
Johnston (1948)	T10
Underwood (1950)	T10 T11 T12
Mitchell (1953)*	T11 T12 L1 L2

\*Mitchell like Hinsey (1943) stresses the variability in these levels.

Further /


SPINAL SEG - MENT 	SOURCE OF EVIDENCE														SUMMARY OF EVIDENCE			
	KUNTZ	MORLEY	JAMIESON	MARTIN	WHITE	POTTENGER	JOHNSTON	UNDERWOOD	MITCHELL	Case 25	Case 28	Case 29	Case 30	Case 31		Case 32	Case 33	Case 34
T5																		
T6														x				
T7														x				
T8										X				x				1
T9										X				x				1
T10	X		X	X	X	X	X	X						x		x	X	8
T11						X		X	X		X	X		x	x	x	X	6
T12						X		X	X		x	X	x	x	x	X	X	6
L1		X							X		x		X	x	x			3
L2		X							X					x	x			2
L3														x	x			
L4														x	x			
L5																		

Figure 50

Further evidence pertaining to the segments concerned is provided by a study of Cases 25 and 28 - 34 in the present series, and the levels suggested by these clinical cases are summarised in the following table:-

Case	Spinal Cord Segment
25	T8 T9
28	T11 (T12) (L1)
29	T11 T12
30	(T12) L1
31	Below T5
32	Below T10
33	(T10) (T11) T12
34	T10 T11 T12

The segments shown in the above tables are diagrammatically represented in Fig. 50. It can be seen that the weight of evidence favours segments T10, T11 and T12 for entry into the spinal cord of testicular afferent fibres, but that considerable spreading of the entry appears to occur. By this it is meant that in any one patient the afferent fibres from a viscus enter the spinal cord over several segments (e.g. T9, 10, 11, 12 and L1), but that more fibres enter through the central segment of the group (T11), fewer through the segments immediately adjacent (T10 and T12) and still less through the more peripheral segments of the group (T9 and L1). This could in turn be held to account for the vagueness of localisation of the stimulus and the spreading of visceral pain over several body segments. The similarity between the diffuse pain of perforated duodenal ulcer and of severely exacerbated duodenal /

duodenal ulcer is thus theoretically acceptable because of the involvement of several body segments, the pain of both conditions being visceral in origin.

#### The Mechanism and Rationalisation of Testicular Pain

Increase in tissue pressure appears to be an adequate stimulus to produce pain: the "sympathetic" afferent fibres do not seem to respond to touch, prick or scratch alone. The stimulus of raised pressure (i.e. distension of the viscus) has to be applied fairly rapidly to elicit a response; this applies to the pain experienced by a patient developing acute retention of urine but the patient with chronic retention of urine, where the condition develops slowly, may suffer only slight discomfort even although the ultimate distension is greater.

Brown (1949) pointed out that tissues supplied by "sympathetic" afferent fibres have a high threshold to stimulation and require a wide (spatial) stimulus before the threshold is crossed. Woollard and Carmichael (1933) concluded that the threshold for pain varied with the level of reference of that pain: thus they found that 300 g. weight applied to the scrotum caused pain referred to the scrotum, that 500 g. was necessary for reference to L1 segment to occur, and that 800 g. was required to give reference to T10 segment. This opinion would support the idea of the diminishing number of fibres entering the cord at /

at successively higher levels (see p. 98 and Fig. 50) and requiring a greater stimulus to cross the threshold of that segment.

As a result of the experiments in the present series and of the evidence available in the literature, it would seem that the best explanation of the pain resulting from testicular stimulation and its reference to other sites is that put forward by Cohen (1947) and later detailed by Ruch (1949):

Testicular afferent impulses ascend along "sympathetic" afferent fibres alongside the testicular vessels to reach the inter-mesenteric (and perhaps also the renal) plexus: from there these afferents travel to enter the spinal cord at one of several segments in the region of T10, T11 and T12. In each segment the visceral afferent fibres converge upon spino-thalamic cell bodies which also receive afferent fibres from the skin of the corresponding body segment. Thus visceral and peripheral stimuli are combined and the total effect therefore varies by changes in either component. The arrival of afferent impulses in any segment will be interpreted as occurring in that segmental area which normally transmits peripheral environmental information via that segment. Furthermore, the response may be enhanced by increase in the peripheral component of the sum, as for example by pressure of the examining hand on the peripheral area of reference; in this /

this way the enhanced response might be called "tenderness". It would seem from the evidence that the testis, as a viscus, takes with it in its descent its original innervation and refers its pain to the segments of the body from which it developed.

This explanation is in keeping with, and indeed supports, Brown's (1942) conclusion that "sensations produced in tissues which have been developmentally or artificially displaced from their primary relative positions and which retain only their original innervation are invariably localised in the respective primary relative positions of those tissues".



SUMMARY

1. Visceral pain in general is discussed, special reference being made to pain originating in the testis, to the nerve supply and to the development of the testis in the light of the various theories mentioned.

2. Case reports are summarised especially with reference to:

(a) Patients suffering from pain resulting from disease of the testis.

(b) Testicular pain sensation in various clinical states.

(c) Patients suffering from hydrocoele of the tunica vaginalis testis who were investigated to determine their ability to detect pain arising in the tunica.

3. After study of these cases and the evidence available in the literature, the following conclusions are reached:

(a) Early in the pathological process pain arising in the testis is referred to the lower abdomen or groin and not to the scrotum.

(b) Ignorance of this fact may well account for the late diagnosis of such lesions as torsion of the testis.

(c) /

(c) The tunica vaginalis testis is not supplied by the genito-femoral nerve and indeed the tunica itself appears to have no afferent supply which responds to the stimuli used.

(d) Capps' (1932) theory of the sensitivity of the peritoneum may not be valid.

(e) The afferent pathway of testicular pain appears to enter the spinal cord over a number of spinal segments, Thoracic 10, 11 and 12 being the most common.

(f) Raising of the pressure within the testis is a stimulus which evokes pain.

(g) The theory of Cohen (1947) regarding the summation of visceral and cutaneous afferent impulses and that of Ruch (1949) regarding the sharing of a common spino-thalamic secondary afferent neurone for these impulses, are supported by the evidence presented.

(h) The theory of Brown (1942) that the site for reference of pain can be explained by the primitive embryological position of the viscus concerned is also supported by the evidence presented.

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APPENDIX

SUMMARY OF EXPERIMENTS OF  
WOOLLARD, H.H. AND CARMICHAEL, E.A. (1933).  
"THE TESTIS AND REFERRED PAIN". BRAIN, 56, 293.

This paper deals with a series of experiments on pain produced by the application of graded weights to the testis after different parts of the scrotum had been anaesthetised to block the various nerves - posterior scrotal, ilio-inguinal and genito-femoral. The tests were made by placing a scale pan on the scrotum, the latter being supported on the fingers of the examining hand. Weights were then added to the pan, the pan being removed from the scrotum between the addition of each successive weight. The nerve blocks were carried out using 4% Novocaine containing 1:60,000 adrenaline.

Experiment 1

Posterior scrotal nerves on left side blocked.

<u>Left Testis:</u>	300 - 500 g. caused slight to moderate discomfort in left groin. 1000 g. caused severe pain in left groin.
<u>Right Testis:</u>	300 g. caused discomfort in right groin. 300 - 500 g. caused vague pain in right testis. 650 g. caused severe pain in right testis.
<u>Conclusions:</u>	When scrotal nerve supply is blocked (posterior scrotal nerves) testicular pain is referred to the inguinal canal region in the territory of first lumbar segment.

Experiment 2 /

### Experiment 2

Posterior scrotal nerves on left side blocked.

Right Testis: 300 g. Uncomfortable feeling in right testis.

500 g. Discomfort in right testis.

725 g. Pain in right testis.

Left Testis: 500 g. Dull ache in left groin.

625 - 725 g. Definite ache in left groin.

Conclusions: When posterior scrotal nerves are blocked sensation (from testis) is felt in the groin in the first lumbar segment.

### Experiment 3

Injection of attachment of scrotum in region of external abdominal ring.

Pain was localised to the testis.

Conclusion: This anaesthesia, which affects branches of the ilio-inguinal nerve was without effect on the sensation aroused in the testis.

### Experiment 4

Injection of left posterior scrotal nerves, neck of scrotum then injected, pushing cord well away. This abolished the left cremasteric reflex.

Left Testis: 200 - 600 g. No sensation.

850 g. Vague sensation in the abdomen, not possible to say where.

Conclusions: None stated.

### Experiment 5

Posterior scrotal and ilio-inguinal nerves injected. Needle then inserted into external inguinal ring pushing cord aside. This resulted in anaesthesia of left scrotum and almost abolished the left cremasteric reflex.

Right Testis: 300 g. Pain in testis.

Left Testis: /



Left Testis: 450 g. Vague sensation in abdomen above Poupart's ligament.  
500 g. Ache just internal to anterior superior iliac spine.  
700 g. Dull ache in upper pole of testis and lumbar region of back.

Conclusions: Because of the absence of pain referred to the groin at 500 g. as was found in the previous experiments when the genito-femoral nerve was known to be intact, the authors state that they are "inclined to the opinion that the responses obtained from this subject do not depend on the escape of some fibres of the genito-femoral nerve from the action of the anaesthetic. This leads to the supposition that both the referred pain in the tenth dorsal segment and the pain described as though it were situated in the upper pole of the testis depended on the presence of afferent fibres mingled with the sympathetic fibres reaching the testis."

#### Two Patients with Spinal Cord Injuries

Case 1.- Patient anaesthetic T11 segment and below. Pain induced by digital pressure on the testis was referred to a point half-way between the anterior superior iliac spine and the umbilicus, and also to the mid lumbar region - "the maximal points of reference of T10 segment".

1000 g. weight applied as before caused only the dorsal pain.

Severe handling of epididymis and cord failed to evoke a response.

Case 2.- Patient anaesthetic on right side from L2 segment and below. Patient anaesthetic on left side from T10 segment and below.

On the right side, this patient referred testicular sensation to the groin (500 g.) and at 1000 g. to a point just to the right of the umbilicus and in the mid-lumbar region. On the left side there was no sensation.